

Current Science



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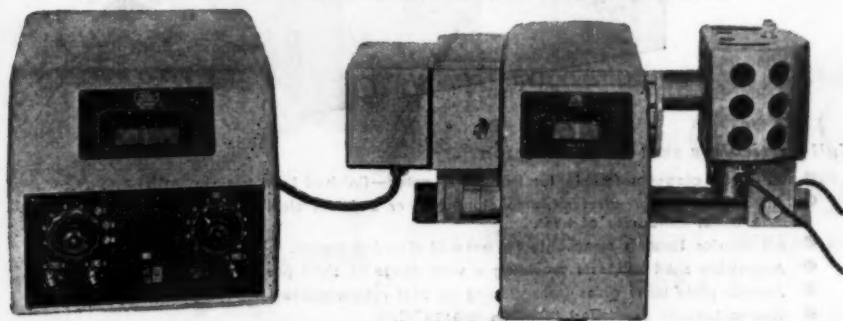
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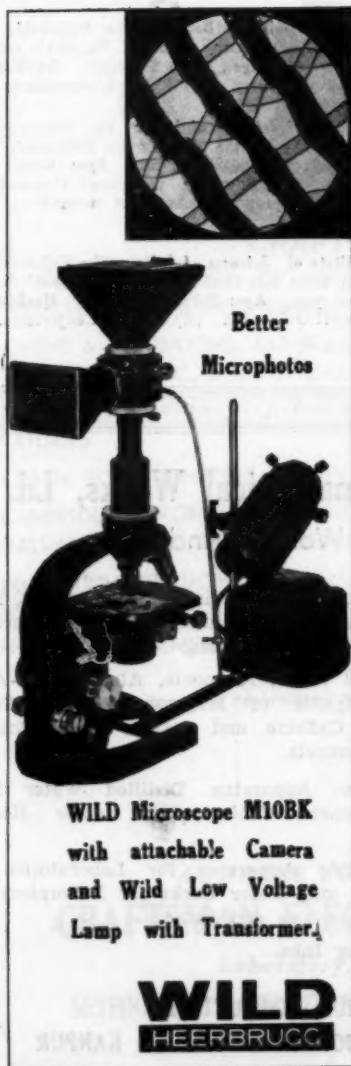
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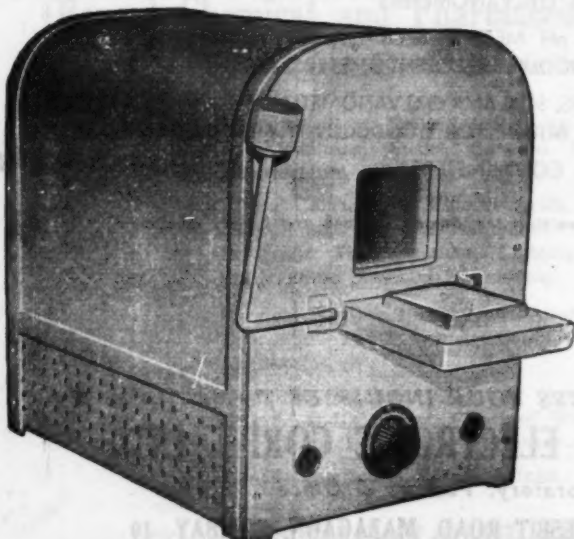
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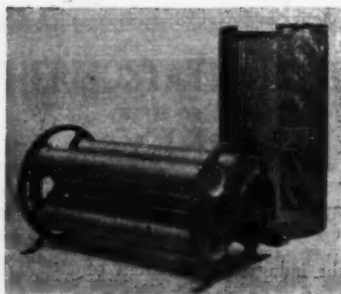
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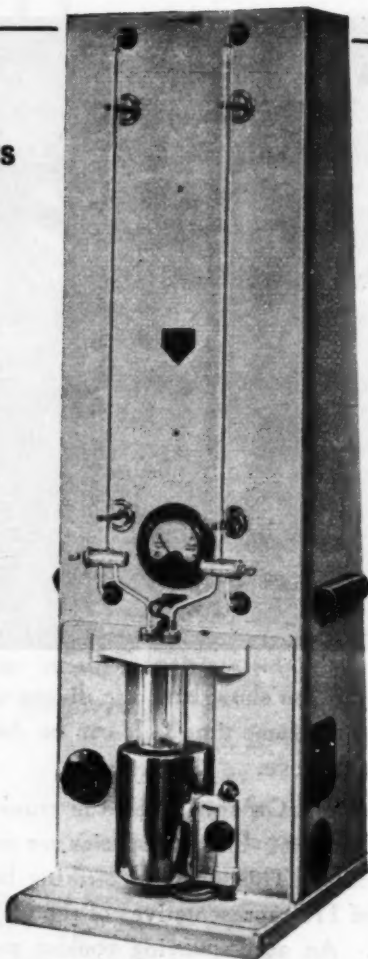
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INDIA'S RESOURCES IN ATOMIC MINERALS*

DEVELOPMENTS arising out of atomic research are likely to transform the world in the next twenty years by endowing it with a new source of power so versatile and responsive to human needs that it will put into shade the present three conventional sources of power, coal, petroleum and electricity. At present uranium holds the field as the primary fission metal in nuclear power production and thorium is a close second. There are, however, indications based on experimental data that soon there will be a neck-to-neck race, and the odds are that thorium will emerge as a fission fuel of greater potential than uranium in the near future. This prediction was made in several documents presented at the memorable Geneva Conference on the Peaceful Uses of Atomic Energy. The conversion of

thorium into U 233 in a breeder reactor is no longer a mere speculation. Thus the indications are that thorium will constitute, in the near future, a power resource of incalculable value in India, and this fact is being given prime importance in the plans that are being formulated by Prof. Homi Bhabha for employment of nuclear energy for peaceful uses.

The basic raw materials required for nuclear energy production are minerals and ores carrying: uranium, thorium, beryllium, lithium, zirconium and graphite. There are besides these a few subordinate natural mineral substances required as integral and shielding parts of nuclear power reactors. The procurement of these secondary minerals presents no difficulty, because India is in a comfortable position in having indigenous supplies and also because their import from open world markets is easy.

URANIUM

Uranium in India is principally a product of igneous and metamorphic rocks, its genesis

* From the Sir Thomas Holland Memorial Lecture entitled *India's Mineral Potentiality for Atomic Energy*, by Dr. D. N. Wadia, Geological Adviser, Ministry of Natural Resources and Scientific Research, Govt. of India.

being due to epithermal, mesothermal or hydrothermal agencies in granitic magmas, or to epigenetic action in large shear or thrust-zones.

Uranium ores in India belong to three categories: (i) Low-grade ores disseminated in Singhbhum and parts of Rajputana in Archaean and Dharwar rocks—The uranium content in these rocks varies from 0.03 to 0.1% with a few thin stringers and nests of higher concentrations. The poorer grade rock is available in large tonnage, a ton of rock yielding from $\frac{1}{2}$ to $2\frac{1}{4}$ lb. of uranium. The ore mineral present in this type is probably a primary uranium compound, capable of simple chemical leaching by the acid or carbonate methods. (ii) Complex uranium minerals occurring in pegmatites and other vein deposits—niobates, tantalates and titanates of uranium—form the second category. These have higher uranium content but their occurrence is highly sporadic. These ores are again difficult to process chemically as well as metallurgically. The more important pegmatites carrying uraniferous deposits are found in the Mica Belt area of North Bihar, mica mines area of Nellore in Madras and Central Rajputana. (iii) The monazite sands of Travancore and Madras coasts—The voluminous ilmenite (black sand) accumulations of these coasts, containing from 0.5 to 2% of monazite, constitute an easily accessible source of uranium, the exploitation of which will liberate large volumes of thorium and other rare-earth compounds. Average monazite yields from 0.2 to 0.46% of U_3O_8 and from 8 to 10% of ThO_2 . There are varieties of monazite much higher both in thorium and uranium values, e.g., the newly discovered variant (?) of monazite, the rare 'cheralite', which carries 4 to 6% U_3O_8 , besides 19 to 33% ThO_2 . Estimates of uranium available from the major monazite sand spreads located at various sites in the Malabar Coast and on the Coromandel Coast are of the order of several thousand tons.

THORIUM

The main source is monazite, a monoclinic phosphate of several rare earths and metals. The thorium content of Travancore monazite ranges from 8 to 10.5% as against 5 to 6% of the Brazilian and other foreign monazite. It occurs both as crystalline aggregates in granitic rocks of Hazaribagh, Mewar, Western Ghats and Madras, and as a constituent of beach-sands on the Malabar and Coromandel Coasts. It is the latter which constitutes the chief source of thorium metal, and the scale of mag-

nitude of its concentration on the Travancore littoral makes it an asset of world importance. The monazite has accumulated along with ilmenite, rutile and zircon along the seashores by a process of natural concentration out of the products of rock decay in the course of long geological ages. Detailed quantitative survey of the monazite occurring on Travancore-Cochin littoral has just been completed; it gives a total estimated reserve of a little over a million tons, for this sector of the west coast. A series of fresh occurrences of ilmenite containing variable percentages of this mineral, has been brought to light within the last three years at several widely scattered localities. These extend from Cape Comorin to as far north as the Narmada estuary on the west coast and beyond the Mahanadi from Tinnevely on the east coast. From data so far available, a provisional estimate of two million tons of monazite, carrying between 1,50,000 to 1,80,000 tons of ThO_2 , may be accepted as a rather conservative figure.

The new mineral, cheralite (percentage composition: ThO_2 —31.4, U_3O_8 —4.43, P_2O_5 —24.53 and SiO_2 —3.12) and probably some other unnamed variants of monazite, with their thorium content as high as 19 to 33% found in recent years in small quantities in their rock matrices, though not likely to swell this figure materially, will form valuable local sources of supply of the highly potential fission metal.

OTHER MATERIALS

The rare metal beryllium, which is used as a moderator in atomic power plants, is available in India in the form of the mineral beryl, which occurs in fairly widely distributed pegmatites in various parts. Since 1949, fairly extensive workable deposits have been discovered in parts of Rajputana and North Bihar, and the production of dressed beryl has risen to over a thousand tons per year. The stock-piling of this mineral in India is a feasible proposition and is being pursued.

Lithium, which is a likely source of helium in future thermo-nuclear fusion developments, occurs as a constituent of the minerals lepidolite and spodumene, occurrence of which in appreciable amounts are recorded from several localities. The Department of Atomic Energy can easily draw its requirements from known deposits.

India possesses large resources of zirconium in the mineral zircon. Zircon forms about 6% of the raw ilmenite sands of Travancore, but contains about 5% of hafnium, which has to be eliminated in the refining of zirconium for

atomic use. Another source is the mineral baddeleyite, also known in Travancore sand.

Graphite of a high degree of purity, especially free from boron, is required in the atomic reactor but is rarely found in the natural state. With four petroleum refineries in the country treating over $3\frac{1}{2}$ million tons of crude oil yearly, there should be enough petroleum coke available for manufacture of artificial graphite.

PROSPECT FOR THE FUTURE

The vast extent of India covered under ancient crystalline rock formations, both in the Deccan Peninsular shield and the extra-Peninsular region of the north, particularly the Himalayan terrain, yet remains to be examined for its uranium potential as well as resources in ancillary atomic minerals. The million square mile Archæan and pre-Cambrian rock expanse, with its cover of basic lava flows in the north-west (many of which are known to have measurable content of uranium of the order of 10^{-6} gram per gram of rock), is covered only in comparatively insignificant proportions by systematic geological prospecting and survey for uranium. So far the Himalayan region has

hardly been touched by these surveys. The Himalayas are regarded as generally barren in sizable mineral or metal veins or lodes. Its very recent orogeny and the observed poverty of this region of middle and late Tertiary uplift in metallogenic provinces has influenced this attitude amongst Indian geologists. But large areas of the inner Himalayas are yet geologically *terra incognita*, and need to be investigated by aerial geophysical surveys, especially in the central and axial parts of the range which are marked by a series of granitic and gneissic intrusions of immense sizes.

A planned programme of investigating these areas by ground and aerial surveys has been formulated, and the strength of the geological and physical personnel engaged in the Raw Materials Division of the Atomic Energy Department is being gradually increased.

It would be hazardous to predict any large accessions of uranium and thorium from these hitherto unknown regions; at the same time the prospect of discovering many commercially workable uranium deposits in new fields cannot be ruled out.

THE ANTIPROTON

SINCE the discovery of the positron by Anderson, confirming Dirac's prediction on the basis of his theory of the electron, it has been generally assumed that the proton would also have its charge conjugate, the antiproton, a stable particle identical with the proton in mass and spin and having charge and magnetic moment equal but opposite to those of the proton. It would be expected to be generated in pairs with ordinary nucleons and to have the ability to be annihilated in interaction with them.

Workers at Berkeley have now announced the identification of antiprotons (by mass determination from momentum and velocity measurements) among particles generated by bombardment of a copper target by 6.2 BeV protons from the Berkeley bevatron. A minimum energy of 5.6 BeV is required for antiproton production in nucleon-nucleon collisions. They measured the momentum (p) by an arrangement of magnetic lenses and fields which select negative singly charged particles with $p = 1.19$ BeV/c; and velocity by a time of flight determination between two scintillation counters

40' apart. About 250 particles, with average mass of 1840 ± 90 electron masses, were thus found. These were separated from the large number of accompanying π -mesons ($> 44,000$ per antiproton) of the same momentum (and hence greater velocity) by making use of the velocity sensitivity of Cerenkov counters. Existing observations on stability and interactions of the particles are consistent with their identification as antiprotons.

The existence of the antiproton entails with virtual certainty the existence of the antineutron. Its experimental demonstration is a most interesting problem. Probably the neutron beam of the Berkeley bevatron contains an appreciable number of them, but their disentanglement from the ordinary neutrons appears a formidable task. It is likely that the best approach will be either: (1) to transform an antiproton into an antineutron by a collision with a proton; or (2) to convert an antineutron into an antiproton by collision with an ordinary neutron and detect either the antineutron or the antiproton produced by this process.—(Nature, 1956, 177, 11.)

BATHYTHERMOGRAMS—AN OCEANOGRAPHIC TOOL

E. C. LA FOND

Andhra University, Waltair

BATHYTHERMOGRAMS—the Temperature versus Depth graphs made automatically by the bathythermograph as it is lowered into the sea, provide a wealth of information about the secrets of the sub-surface layers. These T-D data are easily acquired in a matter of a few minutes, and produce results with a remarkable degree of accuracy. When the various T-D data are studied and compared with other oceanographic factors they reveal many of the processes taking place in the sea.

The bathythermogram is important to every branch of oceanography. The marine biologist is aided in his efforts to determine the environment in which plants and animals flourish. The marine chemist requires the temperature structure in order to determine chemical reactions and the saturation point of the salts and gases. The physical oceanographer is especially concerned with the T-D character of the water, for the physical properties of the water itself are dependent upon its temperature. For example, water density, surface tension, viscosity, sound velocity, etc., are a direct function of temperature. For these many reasons, the study of the temperature of the sea has become an integral part of the oceanographic research programme at the Andhra University.

The vertical temperature structure of the sea off the Indian coasts may be described as a three-layer system, somewhat analogous to layers in the atmosphere. The upper or surface layer is called the "thermosphere" and consists of a changing zone of relatively warm near surface water. It is separated from the lower psychrosphere by the thermocline, a layer in which the temperature changes most rapidly with depth. The psychrosphere remains a comparatively stable colder region (see Fig. 1).

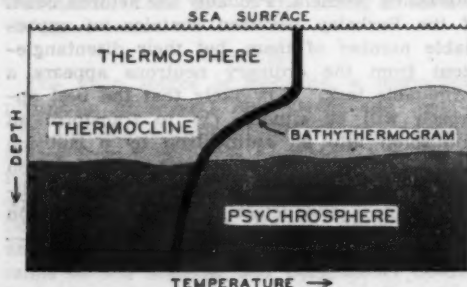


FIG. 1. Common type of bathythermogram and the related layers of the sea.

In this simplified version of the temperature structure, changes are continually taking place through external and internal forces such as tide, current, wind, etc. Also, heat exchange to and from the atmosphere occurs at the sea surface, which in turn, modifies the temperature structure in the thermospheric layer. Some of these environmental factors have a characteristic effect on the shape of the bathythermogram. These are sometimes discernible and reflect the history of the physical processes that have taken place in the water.¹ Several different types of bathythermograms are presented in Fig. 2 and their probable formation is discussed.

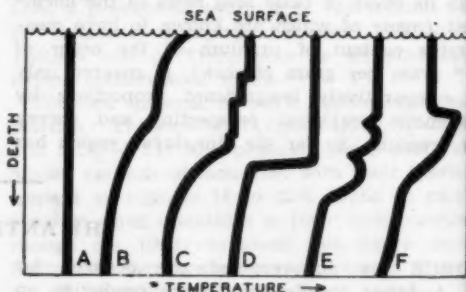


FIG. 2. Various types of bathythermogram observed in the Indian Ocean.

If the bathythermogram shows a continual vertical trace, i.e., isothermal water, from the surface to a depth of a few hundred feet, as shown in Fig. 2 A, it indicates that the water has been vigorously mixed by a strong wind, or that vertical advection by cooling at the surface has taken place. In the winter both processes frequently occur. A tropical hurricane in the Arabian Sea or Bay of Bengal will produce such isothermal bathythermograms.

In Fig. 2 B, the usual three-layer system is present. The thermocline has a gradual slope which is caused by diffusion and gradual mixing at that level. The increased temperature at the surface represents conduction of heat to the water from the atmosphere under low wind conditions. This type of T-D curve may be commonly found in the summer whenever the wind is light and the air is relatively warm and moist.

The step-like structure in the thermosphere depicted in Fig. 2 C is usually the result of successive surface heatings and wind mixings. Spring is the favourable season for such sur-

face water heating, through increased solar radiation and conduction and, coupled with irregular winds, produces this type of T-D structure.

The sharp thermocline boundary between thermosphere and psychrosphere, as shown in Fig. 2 D, occurs when one adjacent water-mass of different temperature flows over another at a different rate of speed or in a different direction. The diffusion of water and heat at the boundary of two such water-masses under these conditions is small. A similar T-D structure may also occur when a warm water type flows over a sub-surface depression or when a large river enters a colder sea. In each case the lighter water flows over the more dense layer without appreciably mixing at the thermocline.

Irregular wiggles in the bathythermogram, as illustrated in Fig. 2 E, are indicative of turbulence at current boundaries. These occur in the stronger current systems. For example, off promontories like the Godavari Delta, the along-shore current increases in speed and at the same time intermingles with coastal waters. This type of irregular and variable temperature structure is the result.

In Fig. 2 F is shown an increase in temperature below the surface, usually the result of cooling at the surface. In this case, the surface layer must contain low salinity water in order that the vertical column may remain in stable equilibrium. Along the east coast, immense quantities of fresh-water mix with Bay of Bengal water, producing a dilute thermospheric layer. In the fall, the surface cools by evaporation and conduction of heat to the atmosphere, causing vertical advection in the low salinity layer. Due to the higher salinity in

the thermocline the stability of the water is maintained, even with higher subsurface temperatures. Actually, the T-D structure of both Figs. 2 C and 2 F could indicate horizontal advection of a different shallow water-mass into the sampling area. However, the cooling and mixing process is the more common.

Various other shapes or combinations of shapes exist along the Indian coasts. Most can easily be explained. However, the cause of one feature shown in the deepest part of Fig. 2 C, namely, an isothermal layer near the bottom, is not apparent. Such a water structure exists on the edge of the continental shelf off Visakhapatnam in the spring. It might be caused by, (1) turbulence as the water flows across the bottom, or (2) by selective infiltration of water of a single temperature. This latter may be connected with upwelling along the continental slope at this time of year.²

These deductions are from a single bathythermogram. With many bathythermograms much more information can be ascertained. For example, repeated lowering in one location will give a measure of the wide variability and time cycles (diurnal, tidal, seasonal, etc.) in the water temperatures.³ A line or network of observations will give two or three dimensional information. Consequently, from the character of a single bathythermogram, or group of bathythermograms, it is possible to deduce the processes that have taken place in a vertical water column in the sea. The bathythermogram is indeed a useful oceanographic tool.

1. La Fond, E. C., *Memoirs in Oceanography*, Andhra University, 1, 94.

2. —, *Ibid.*, 117.

3. — and Poornachandra Rao, C., *Ibid.*, 109.

PEACEFUL USES OF ATOMIC ENERGY

THE United Nations wishes to announce the forthcoming publication of the Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, held in Geneva, during August 1955, in their entirety.

Peaceful Uses of Atomic Energy will be published in sixteen volumes, each approximating 500 pages; they will comprise all papers submitted at the Conference (about 1,050), the text of the oral presentations at Geneva, and the verbatim record of the discussions on the Geneva papers. The publication provides for the first time a complete reference work on all the peaceful uses of atomic energy and will remain the standard text and basic documentation on this subject for many years.

Volume III, entitled, "Power Reactors", is the first of the sixteen to be printed, and has been released recently. It describes reactors now operating and plans for future reactors that will produce usable power in the form of heat or electricity. The types of fuels and how they will be used are also considered in this volume, which carries nearly 400 illustrations.

A complete list of the sixteen volumes is given at the end of this release, with the prices of each volume. The price for Volume III is \$7.50. Copies can be ordered from United Nations Official sales agents in various countries, or from H.M. Stationery Office, P.O. Box 569, London, S.E. 1.

THE PRIMARY COSMIC RADIATION*

COSMIC radiation was discovered nearly 50 years ago. Its effects were first observed as a small residual ionization in gases, which could not be attributed to natural radioactivity of the earth and of its atmosphere. From this modest beginning, a branch of physical science has developed which has profoundly affected and in some cases even revolutionized other fields of physics and has exerted a great influence on the development of other sciences, in particular, astrophysics and archaeology. Increasingly important contributions of cosmic ray research to geophysics, oceanography, meteorology and cosmology, possibly even to the biological sciences, must be expected.

In order to understand why results obtained in the study of cosmic rays have reached so far afield and have affected so many different branches of knowledge, we must consider separately three different aspects of the phenomenon of cosmic radiation: the incident particles themselves, the dissipation of their enormous energy inside the atmosphere, and the radioactivity which cosmic radiation produces on the surface of the earth.

The outer atmosphere of the earth is continuously being bombarded from all sides by various forms of radiation and matter: photons of greatly varying wavelengths, a stream of atomic nuclei of widely varying mass and energy, as well as aggregates of matter ranging in size from very fine particles of dust to that of large boulders. Our entire knowledge about the properties of the solar system and of the universe which surrounds us and of which we form an insignificant part, even our awareness of the very existence of this universe, is based on a study of some part of this radiation and matter which bombards us. The study of the electromagnetic radiation in the visible part of the spectrum has by far the longest scientific history and is responsible for most of our present knowledge of the universe around us, while the study of the incident particle radiation is comparatively new. Yet it has already taught us that the interstellar medium not only consists of turbulent gases and dust, but that it also consists of atomic nuclei moving with relativistic and near relativistic velocities and that it contains magnetic fields. One finds that the energy density due to cosmic radiation, to magnetic fields and to

the kinetic energy of interstellar matter are of the same order of magnitude. It is clear that these facts alone are of the greatest importance for theories dealing with the development of stars and galaxies and is fundamental to all problems of cosmology. The details of the chemical composition of cosmic radiation, its density and velocity distribution, its variations in time and space, will have to be understood in terms of the present physical conditions of our universe and thereby serve as tools to explore these conditions. In this way cosmic ray physics has become a part of astrophysics and cosmology.

On impact with the atmosphere the particles of the cosmic radiation destroy nitrogen and oxygen nuclei which they encounter and decompose them into their constituent parts (protons, neutrons and aggregates of these particles); in addition, a large part of their enormous kinetic energy is transformed into a variety of highly unstable particles which subsequently decay through complicated chain events back into stable forms of matter. It is clear that the appearance of these particles (which are called mesons and hyperons) in high energy collisions is closely linked with the properties of the colliding protons and neutrons and is useful in explaining the force responsible for their aggregation into the nuclei of elements which we observe on the earth. The role which these unstable particles play in the structure of matter is not yet clear; almost all of them were first discovered in cosmic radiation, and these discoveries provided the impetus for building the large accelerators which now are among the most valuable tools for the investigation of nuclear forces. Thus cosmic ray physics is an important part of nuclear physics.

The significance of cosmic ray work for archaeology, geophysics, oceanography and meteorology rests on the fact that during the complicated processes of interaction between cosmic radiation and its progeny with the atmosphere and the surface of the earth, a number of radioactive nuclei are produced with greatly varying half lives. These half lives, though often quite long, are much shorter than those of naturally occurring radioactive substances which have survived in measurable quantities on the earth and in meteorites since the creation of elements some 5 billion years ago. There are two ways in which these radioactive nuclei are produced by cosmic rays. They may be produced directly by the partial

* Abstract of Presidential Address of Prof. B. Peters to the Physics Section at the 43rd Session of the Indian Science Congress, 1956.

fragmentation of nuclei in the air, or they may be produced by the capture of cosmic ray-produced neutrons after these neutrons have been slowed down.

The first group contains the recently discovered cosmic ray-produced Be^7 (half life 53 days), which may be useful for studying the circulation of air-masses between the stratosphere and lower atmospheric layers, and may also give information on the vertical circulation of ocean water. Another collision product is tritium (half life 12.5 years), whose concentration in lake and well water reservoirs has been used to obtain information on the rate at which these reservoirs are fed by contemporary water from recent precipitations.

Among the radioactive isotopes produced by slow neutron capture, the most important one is C^{14} (half life 5,600 years) which has been used primarily to determine the time at which various organic materials have ceased to participate in the exchange of CO_2 between the atmosphere and the biosphere. The time of death can, therefore, be measured from the C^{14} concentration in the remains of plants, animals of humans and this technique has proved of great value for archaeological research.

Whether cosmic radiation is of importance to the biological sciences, is not clear. Since all high energy radiation is capable of producing mutations, continuous cosmic ray bombardment, particularly at high elevation, must have been responsible for some genetic changes. It may, however, not be of sufficient importance, compared with other agencies of mutation, to have influenced markedly the history of evolution.

The experimental results on the primary cosmic ray nuclei have shown how their chemical composition, state of ionization, energy spectrum, spatial isotropy and intensity variations in time can be used to derive information on (1) the composition and temperature distribution of the region of the galaxy in which the particles originate; (2) the nature of their

trajectories in interstellar space; and (3) the distribution of gas clouds and magnetic fields in the galaxy and in the solar system.

Various theories have been proposed as to how particles could be accelerated in the galaxy to very high energies. Magnetic variable stars, and stars whose magnetic axis does not coincide with their axis of rotation have been investigated in some detail as possible accelerators. The conversion of the kinetic energy of interstellar gas clouds into cosmic ray energy has also been considered. There are serious objections to these proposals. Nevertheless it is possible that they play a role in the production of cosmic rays.

However, one celestial object has been discovered which does accelerate particles to cosmic ray energies, although we do not understand how it accomplishes the acceleration. The object is the so-called Crab Nebula, a rapidly expanding luminous gas cloud resulting from the explosion of a supernova, which according to Chinese sources occurred about 900 years ago. The total energy which is converted in the Crab Nebula into kinetic energy of particles is of a magnitude which is perhaps sufficient to account for the total observed cosmic ray intensity if one assumes that (as indicated by observations on other galaxies) our galaxy produces on the average one supernova every 200 or 300 years.

It is not clear as yet, whether the observations on the Crab Nebula are consistent with its emitting cosmic ray particles of energies as high as 10^{10} e.v. or whether we have to look for other mechanisms in this ultra high energy region. The detailed mechanism of acceleration and the origin of the enormously high magnetic field energy appearing in this supernova explosion are also as yet quite unknown. Nevertheless the existing evidence gives strong support to the hypothesis that supernovae and perhaps novae are sources of cosmic radiation.

CONTROL OF CANCER

THE discovery and isolation in pure form of a substance, named fertilizin, which produces a serum that inhibits the division and multiplication of specific cells was announced at the annual meeting at Atlanta, Georgia, of the American Association for the Advancement of Science.

The substance was isolated from the gelatinous coat of a sea urchin's egg by Dr. Albert

Tyler, Professor of Embryology at the California Institute of Technology. When injected into rabbits or chickens, it leads to the production in their blood of serum that acts specifically against the dividing mechanism of the fertilized egg.

Fertilizin is described as belonging to a group of substances, glycoproteins, made up of sugar and amino acids.

SOME PROBLEMS OF GONDWANALAND

SINCE the idea of Gondwanaland was first put forward seventy years ago, considerable work has been done in different areas on the stratigraphical, palaeontological and tectonic aspects as a result of which we have some idea of the main events in the history of this ancient continent. But the picture of the geological history of Gondwanaland is still far from being complete. We find that new discoveries from time to time have often revealed new possibilities of interpretation, necessitating constant revision of our older ideas. From an overall review of the present position, it is clear that there are still quite a number of problems connected with Gondwanaland requiring proper elucidation. The object of the present paper is to draw attention briefly to some of these problems.

When and how exactly did the Gondwanaland come into existence? When and how exactly did it disappear? Although we commonly talk of the first appearance of Gondwanaland in the Upper Carboniferous period, and connect its birth in some way with the earth movements of that period (Hercynian), the main question is still there to consider, viz., how was this continent actually built up? What exactly was the position regarding these land masses (comprised within the Gondwanaland) and their mutual relationships in the pre-Upper Carboniferous times? To tackle this point, it is necessary to make a detailed comparative study, age by age, of the terrestrial and fresh-water deposits of the earlier periods, with their faunas and floras, found in the present representatives of Gondwanaland, and determine their mutual relationships.

Regarding the disappearance of Gondwanaland, the current view is that this disruption took place in stages, at different times in different places, during the period ranging from Lower Cretaceous to the Lower Eocene. The exact chronological sequence of these stages, and their connection, if any, with the beginnings of the Himalayan upheaval on the one hand, and the Deccan Trap eruptions on the other, have yet to be worked out. There is also the more fundamental question of how this disruption took place,—submergence and/or drift? It may be pointed out that these studies regarding the appearance and disappearance of Gondwanaland have also an important bearing on the problem of fixing the

lower and upper age limits of the Gondwana system in each of the present different parts of the old Gondwanaland.

There are also the questions regarding the land and sea connections during the Gondwanaland period. What exactly was the nature of the land connections, if any, between the southern Gondwanaland and the northern Laurasia? When and where did these connections exist? Were they continuously in existence in the same places, or were these connections of the 'make and break' (rhythmic) type shifting about in place and time? What exactly was the nature of the connections between the different parts of the Gondwanaland itself? Several views on these matters have no doubt been expressed from time to time, but there is still a lot of confusion and controversy. A proper solution of these palaeogeographical problems must of course take into account the distribution and mutual interrelationships of contemporary faunas and floras. On the one hand, we have cases of admixture of the northern and southern land floras across the Tethys; and, on the other, there are the evidences of admixture of the Tethyan and Indo-Pacific marine faunas across Gondwanaland. All these have yet to be fully investigated and properly interpreted.

Then again, there are the problems connected with the glaciation in Gondwanaland. While the fact of glaciation has been established in several parts of Gondwanaland, the exact age and time-distribution of this glaciation in the different areas, the centres of dispersal of these ice sheets, the question whether there were local or uniformly spread glacial and inter-glacial periods, and, if so, their number and mutual correlation,—are still some of the points requiring full investigation. These studies will also have an important bearing on any theory accounting for this ice age.

In addition to the above, we have the whole field of 'Gondwana Floras' still requiring proper attention. The constituents of the Glossopteris flora in the different parts of Gondwanaland, and their relation to the other contemporary palaeobotanical provinces have yet to be fully worked out. Our knowledge of the Upper Gondwana floras is also very limited. It may be said that the whole field of palaeobotanical investigations of the flora of Gondwanaland still remains to be fully and systematically explored.

The above are some of the major problems (and at some stage, they all get interrelated)—connected with Gondwanaland, requiring further studies. While it is true that on many of these topics, ideas have been expressed and views put forward from time to time, on the basis of local researches, we have hardly dealt with these problems on a 'Gondwanaland basis', as we must do to evolve a consistent and comprehensive view of the geological history of this ancient continent, and fit it in properly within the wider picture of contemporary Earth History as a whole. These basic and fundamental problems cannot be solved by piecemeal

and unco-ordinated research in scattered areas; what is really necessary now is to initiate and carry out intensive and co-ordinated team work according to a well considered 'master plan' to be drawn up by a competent and authoritative agency.

In this connection it is gratifying to note that an International Gondwana Commission has already been set up, and a memorandum incorporating the views of Indian geologists on the subject has been submitted by Dr. D. N. Wadia for discussion at the forthcoming session of the International Geological Congress at Mexico in September 1956.

L. RAMA RAO.

U.S. SATELLITE PROGRAM*

TWO additional areas of activity in relation to the worldwide programmes for the International Geophysical Year 1957-58 are of special interest: rocket studies of the upper atmosphere, and the recently announced satellite studies, which represent a logical extension, technically and conceptually, of the rocket programme.

Rockets permit us to make direct measurements of quantities that are either only indirectly observable or are not observable at all, from the ground. They also provide a technique for measuring the altitude dependence of various geophysical parameters. Unfortunately, rockets have two serious disadvantages: (i) their total flight is extremely short and the time spent in a particular altitude range is even shorter; and (ii) their flight paths are restricted in terms of geographic coverage.

Thus, in spite of the very great value of rocket data, much of which is attainable only by rocket methods, there exists a need for a device that can provide synoptic data over the earth at high altitudes, over appreciable periods of time. As examples, one can cite the following: fluctuations in such solar effects as ultraviolet radiations and X-rays, cosmic ray intensities, current rings encircling the earth, and particle streams impinging on the high atmosphere. These and other phenomena are among the most important problems connected with the physics of the upper atmosphere and with solar-terrestrial relationships.

Clearly an earth satellite would permit observations of the kind indicated above, and the following types of experiments would seem

desirable: (i) determination of outer atmosphere densities by observation of the air-drag effect on the satellite's orbit; (ii) obtaining of more accurate measurements of the earth's equatorial radius and oblateness and of intercontinental distances and other geodetic data than are presently available; (iii) long-term observations of solar ultraviolet radiation; (iv) studies of intensities and fluctuations in intensity of the cosmic and other particle radiations impinging on the atmosphere; (v) determination of the density of hydrogen atoms and ions in interplanetary space; (vi) observations of the Störmer current ring; (vii) if possible, determination of the distribution of mass in the earth's crust along the orbital track.

How many and what experiments will be undertaken cannot be specified at this time. In part, these depend on the number, size, and pay-load capacity of the satellites. In part, they would depend on choices yet to be made by the United States National Executive Committee for the IGY, in collaboration with interested scientists, for in all probability, more experiments will be proposed than can be fitted into the IGY satellite program.

Work on technical details of the satellite is currently under way. Information now available indicate that the satellites will be small; they will contain scientific instruments; they will be trackable from ground by optical and radio techniques; they will probably be visible to the naked eye under optimum conditions at dawn and dusk, and certainly observable under good atmospheric conditions by means of binoculars and wide field optical equipment.

In size, the satellite may be described as about that of a basketball, although the shape

* From an article by Joseph Kaplan and Hugh Odishaw in *Science*, 1955, 122, 1003.

has not yet been fixed. Each satellite will weigh more than 20 lb. but probably less than 50 lb. The satellite will travel about the earth in an elliptical orbit, with a perigee distance of at least 200 miles and an apogee distance of some 800 miles. It is expected that the

satellite will remain in its orbit for at least several weeks and perhaps for months. The velocity of the satellite will be approximately 18,000 miles per hour, giving a period of about an hour and a half, depending on the precise perigee and apogee values.

OBITUARY

DR. S. L. HORA

THROUGH the sudden and unexpected death of Dr. Sunder Lal Hora, D.Sc., FR.S.E., C.M.Z.S., F.N.I., on the 8th December 1955, at Calcutta, Indian Zoology has lost an inspiring investigator and Indian ichthyology one of her most brilliant exponents. He had a heart attack on 5th December while giving a lecture at the Asiatic Society and was removed to hospital where he passed away on the 8th December.

A son of the late Lala Gobind Sahai Hora, Dr. Hora was born at Hafizabad, Punjab, in May 1896. His early education was at Jullundur whence he went to the Government College, Lahore. Lahore was then one of the acknowledged centres of zoological teaching and research in the country, and Dr. Hora belongs to a band of brilliant and outstanding figures that have contributed so much to the shaping of teaching and research in zoology in India. After a distinguished record in college, Dr. Hora was appointed to the Zoological Survey as Assistant Superintendent in 1921. From then on, excepting for five years (1942-47) when he was the Director of Fisheries in Bengal, he served the Survey in various capacities and became its Director in 1947 which post he held till his death.

Dr. Hora's researches covered a wide field. His many memoirs in the publications of the Indian Museum, of the Asiatic Society and other journals in India and abroad, bear testimony to the high quality of his work and his penetrating insight into the problems of the systematics, ecology and evolution of Indian fishes. His knowledge of the fresh-water fishes of the whole subcontinent was extensive and complete, and under his guidance many workers have helped to elucidate problems of the taxonomy and relationships of Indian fishes. He was generous with material and advice, and students and colleagues could go to him with entire confidence of receiving all consideration and help.

He was a member of many learned societies in India and abroad, and was associated with the initiation and development of a large number of scientific organizations in

this country. He was a President of the Indian Science Congress, the National Institute of Sciences, the Zoological Society of India, the National Geographical Society of India and the Indian Ecological Society.

Among the many honours bestowed on Dr. Hora may be mentioned the title of Rai Bahadur in 1936, the Joy Gobind Law Memorial Medal of the Asiatic Society in 1944, the Jawaharlal Nehru Medal of the Indian Geographical Society (1951) and the Sir Dorab Tata Memorial Medal of the Zoological Society (1953). He was also chosen to represent India at a number of international scientific conferences. In 1946, he attended the Royal Empire Scientific Conference and the British Commonwealth Scientific Conference; in 1948, he took a leading part in the FAO Fisheries Conference at Baguio (Philippines); in 1949, at the invitation of the Secretary-General of the United Nations, he opened a discussion on "Pond Culture of Warm Water Fishes" at the U.N. Scientific Conference on the Conservation and Utilization of Resources at Lake Success (U.S.A.). He also represented the Indian Science Congress Association at the Jubilee Meeting of the Australian and New Zealand Association for Advancement of Science at Brisbane (Australia) in 1951 and the Annual Meeting of the British Association for Advancement of Science at Liverpool (U.K.) in 1953. In 1954, he attended as a delegate from India the Second Congress of the Pan Indian Ocean Science Association held at Perth (Australia). Recently, he was designated by the Government of India as a member of the UNESCO panel of experts on human ecology and arid zone research and was to have represented the Indian Science Congress Association at the Annual Meeting of the Pakistan Science Association at Dacca in January 1956.

In recent years he became interested in the ancient Hindu lore of fishes and fisheries, and his contributions in this field constitute an important chapter in the history of sciences in India.

B. R. SESACHAR.

LETTERS TO THE EDITOR

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NEW VIBRATIONAL ANALYSIS OF THE VISIBLE EMISSION BANDS OF Cl_2^+

THE emission spectrum of chlorine as excited in a high frequency discharge is well known to consist of a large number of red degraded bands extending from λ 6500 to λ 3400. Preliminary analysis of the bands was first reported by Uchida and Ota,¹ who arranged them into three systems. Elliot and Cameron² in a re-investigation of the spectrum obtained more accurate data of the bands and arranged some of them into two systems. From the even multiplicity of the levels observed from the

rotational analysis of some of the bands, they concluded that the emitting molecule is Cl_2^+ and attributed the two systems to the transition $^2\Pi-^2\Pi$ although they did not rule out the possibility of a $^4\Delta-^4\Delta$ transition.

Howell,³ in a recent paper criticised the analysis of Elliot and Cameron from various aspects. Firstly, there is a large number of gaps in the analyses and also a large number of bands unclassified. Secondly, the intensity distribution in the systems is inconsistent with the values of ω , and ω' , derived from the analyses. Lastly the energy of dissociation of the ground state $^2\Pi$ of Cl_2^+ is found to be

TABLE I
Isotope effect

SYSTEM I				SYSTEM II				SYSTEM III			
(Cl ³⁵ Cl ³⁵) ⁺		(Cl ³⁵ Cl ³⁷) ⁺		(Cl ³⁵ Cl ³⁵) ⁺		(Cl ³⁵ Cl ³⁷) ⁺		(Cl ³⁵ Cl ³⁵) ⁺		(Cl ³⁵ Cl ³⁷) ⁺	
ν'	ν''	Cal.	Obs.	ν'	ν''	Cal.	Obs.	ν'	ν''	Cal.	Obs.
14,	0	53.2	53	17,	0	63.3	62	13,	0	49.5	49
14,	1	44.6	45	16,	0	60.6	61	12,	0	46.2	46
13,	1	41.3	41	17,	1	54.7	56	13,	1	40.9	38
11,	2	26.1	26	16,	1	52.0	53	12,	1	37.6	38
11,	3	17.9	17	15,	1	49.1	49	12,	2	29.3	29
11,	4	9.9	10	16,	2	43.6	44	11,	2	25.9	26
5,	5	20.4	18	15,	2	40.7	42	5,	5	20.1	20
6,	6	23.9	24	8,	6	14.5	15	5,	6	27.3	27
3,	6	36.2	36	7,	6	18.4	17	6,	7	30.1	32
7,	7	27.2	29	9,	8	24.7	27	3,	8	49.2	47

4.4 e.V. as against the indirectly obtained value 2.23 e.V. derived from the ionization potentials of Cl and Cl₂ and the dissociation energy of Cl₂. From a consideration of electronic configuration for Cl₂⁺ molecule, Howell predicted that the transition involved corresponds to that observed for the neutral molecule. The ratio of the frequencies ω'_e and ω''_e being roughly half in the case of neutral molecule, he suggested that the frequencies ω'_e and ω''_e in the case of Cl₂⁺ should be of the order of 630 and 310 cm.⁻¹

The authors¹ have recently reported the analysis of similar emission bands of bromine in the visible region as belonging to two systems, the ratio ω'_e/ω''_e for each of these being roughly equal to half. As these bands do not bear any relationship with the absorption bands of the neutral bromine molecule in the visible region, on experimental grounds, it may be concluded that the emitting molecule may be Br₂⁺ although a rotational analysis of the bands is necessary to confirm this view (Table I).

In the light of this work on bromine, and also Howell's predictions for Cl₂⁺, the authors have attempted to reanalyse the emission bands of Cl₂⁺. In addition to the data of Elliot and Cameron,² a number of new discrete bands observed by us especially on the longer wavelength have been utilised for this analysis. It was found that almost all the bands belong to four different systems. For three of these systems, the vibrational constants have been derived (Table II).

The first and the second systems are found to have a common lower level which is probably the ground state of the molecule. The

development of the fourth system is rather poor.

TABLE II

	ω'_e	$x'_e\omega'_e$	D'_e	ω''_e	$x''_e\omega''_e$	D''_e	ν_e
System I	350.0	2.0	1.9	656.0	4.6	2.8	20448.4
System II	375.0	2.6	1.7	656.0	4.7	2.8	20736.4
System III	347.5	2.0	1.9	655.0	5.5	2.4	20569.4

The analyses have been confirmed by the following: (i) The vibrational assignments of the bands in the three systems are well supported by the chlorine isotope effect which can be seen from Table I. (ii) They are also consistent with the values of the rotational constants B_v' and B_v'', derived by Elliot and Cameron.² (iii) The energy of dissociation of the ground state for Cl₂⁺, from Birge-Sponer extrapolation method may be either 2.8 e.V. or 2.4 e.V. The indirectly determined value 2.23 e.V. mentioned above is thus of the right order of magnitude. (iv) The intensity distribution in the three systems is of the open Franck-Condon parabola type which is normally to be expected when the ratio ω'_e/ω''_e is approximately half.

Full details of the analyses and discussion of the electronic states are being published elsewhere.

Dept. of Physics, P. TIRUVENGANNA RAO.
Andhra University, P. B. V. HARANATH.
Waltair, September 1, 1955.

1. Uchida, Y. and Ota, Y., *Jap. J. Phys.*, 1928, 5, 53.
2. Elliot, A. and Cameron, W. H. B., *Proc. Roy. Soc.*, 1937, 158A, 681; *Ibid.*, 1938, 164, 531.
3. Howell, H. G., *Proc. Phys. Soc.*, 1953, 66A, 759.
4. Haranath, P. B. V. and Tiruvenganna Rao, P., *Indian J. Phys.*, 1955, 29, 205.

ON THE DETERMINATION OF
DIPOLE MOMENT AND RELAXATION
TIME AT 3 Cm.

In the 3 cm. region dipole moments and relaxation times are usually determined by measuring the variation of the loss, $\tan \delta$, with frequency in dilute solutions of polar substances in non-polar solvents. Potapenko and Wheeler¹ described a method by which these could be deduced from a study of the variation of the complex polarisation with concentration in a non-polar solvent at a single frequency and measured the relaxation times for fatty acids in dioxane at a wavelength of about 25 cm. A study of these two methods suggested the possibility of applying Potapenko and Wheeler's method in the 3 cm. region for the determination of μ and τ from measurements at a single frequency. The real and imaginary parts of the complex dielectric constant $\epsilon^* - i\epsilon''$ could be measured using waveguide techniques with a shorted cell.² The apparatus used is given in the block diagram below.

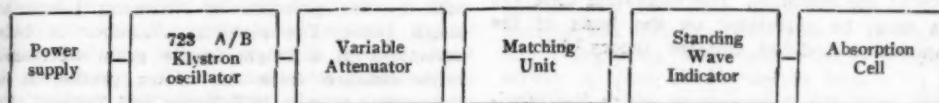


TABLE I

Compound	$\tau \times 10^{12}$ sec. (at 30° C.)	μ	Literature values			
			$\tau \times 10^{12}$ sec. (20° C.)			
			(1)	(2)	(3)	(4)
1 Nitrobenzene	.. 15.5	4.4	13.0	11.6	11.5	..
2 Acetone	.. 1.8	2.4	3.3	3.3	3.2	2.47
3 Benzophenone	.. 8.9	2.5	18.1	16.4	22.0	16.1
4 Acetophenone	.. 7.8	2.6

(1) Cripwell and Sutherland²; (2) Jackson and Powles³; (3) Whiffen and Thompson⁴; (4) Holzmüller.⁵

The polarisation values of P_r and P_s for infinite dilution are deduced graphically. The equations of Potapenko and Wheeler

$$\tau = (1/\omega) P_s / (P_r - P_s)$$

and

$$P_s = \frac{P^2 + (P_r - P_s)^2}{(P_r - P_s)}$$

where P_s , the orientation polarisation and P_r , the sum of the atomic and electronic polarisations, are used to calculate the dipole moment μ and the relaxation time τ . The final values are given in the table below together with the existing values in the literature²⁻⁵ for com-

parison for nitrobenzene, acetone and benzophenone. The relaxation time for acetophenone is determined for the first time. Benzene is used as the solvent in all the measurements. The chemicals are all of the Analar standard of purity.

In view of the limited accuracy of the measurements at these wavelengths, the agreement with the literature values given in Table I may be considered satisfactory.

Full details will be published elsewhere.

CH. RADHAKRISHNA MURTY.

[D. V. G. L. NARASIMHA RAO.

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DIELECTRIC PROPERTIES OF ETHYL
ACETATE IN THE ULTRA HIGH
FREQUENCY REGION

THE dielectric constant and loss tangent were determined for ethyl acetate over a wide range of temperatures and also over a frequency range from 400 Mc/s. to 800 Mc/s. for which data are not available. The output of a U.H.F. oscillator was fed to a short circuited coaxial line filled with the liquid at one end. By adopting the standing wave method suggested by Von Hippel,¹ the above measurements were

made for ethyl acetate. Tables I and II give the temperature variation of the dielectric constant and loss tangent at 800 Mc./sec. over a temperature range from 30-60° C. and the frequency variation at 30° C.

TABLE I

Temp. °C.	ϵ'	Tan. δ
30	5.91	-0.19
20	6.12	-0.21
10	6.36	-0.25
0	6.60	-0.29
-10	6.88	-0.36
-20	7.09	-0.53
-30	6.78	-0.87
-40	5.10	-1.61
-50	4.54	-0.88
-60	4.24	-0.51

TABLE II

Freq. Mc./s.	ϵ'	Tan. δ
900	5.90	-0.19
800	5.91	-0.19
700	5.93	-0.18
600	5.96	-0.17
500	5.98	-0.16
400	6.00	-0.14

The variation of the dielectric constant and loss with temperature in the dispersion region shows that the maximum absorption occurs at -40° C. for 800 Mc/s. The relaxation time (τ) can then be calculated on the basis of the empirically modified Onsager theory,^{2,3}

$$\omega\tau = (1 - \delta)$$

where ω is the frequency at which the maximum absorption occurs and

$$\delta = \frac{1}{3} \beta (\epsilon_{\infty} + 2) (1 - q)$$

where q is Van Vleck empirical factor expressed in terms of the static and the optical values of the dielectric constant, and

$$\beta = 4\pi N\mu^2/9kT$$

where N is the number of molecules per c.c., μ the dipole moment, k the Boltzmann's constant, T the absolute temperature.

The values of δ and relaxation time obtained are:

$$\delta = .2291. \quad \tau = 1.53 \times 10^{-10} \text{ (Temp. } -40^\circ \text{ C.)}$$

Full details of the experimental work and an account of further work on dispersion in pure liquids which is in progress will be published elsewhere.

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STEEL TARGETS ATTACKED BY EXPLOSIVES WITH LINED CAVITIES

When a 'Munroe' jet squirted from a high explosive charge with lined cavity impinges upon a target, it exerts a pressure of about a quarter million atmospheres and the target material flows plastically out of the path of the jet. The changes in microstructure and hardness, and types of fracture observed in steel targets penetrated by Munroe jets are described below.

The metal in the jet spot-welds on the crater surface. The deposit of the steel jet on the crater surface (observed as martensitic regions) indicates that the metal in the jet had definitely attained a temperature more than A_{c_3} point and then suddenly quenched. A shallow layer (0.3 mm.) of the metal of the original target at the surface of the crater got heated beyond A_{c_1} point and was observed as martensitic grains surrounded by ferritic grains. The layers adjoining this region were severely cold worked.

The microstructure of the remaining low-carbon (0.13% C) steel target was characterized by the presence of Neumann bands or shock twins. The maximum number of twin directions in a single ferrite grain decreased with distance from the crater profile. It is interesting to note that Evans and Taylor² also observed Neumann bands in Armco steel targets penetrated by steel jets. In medium-carbon (0.4% C) steel targets,³ Neumann bands were not observed and the microstructure was characterized by severe grain distortion and flow, which also decreased with distance from the crater profile.

The hardness measurements taken along a radius of a circular cross-section of the low-carbon steel target showed an abrupt drop in hardness near the profile of the crater and a series of plateaus along which the hardness remained constant in each hardness *versus* distance curve. No such plateaus of constant hardness were observed in medium-carbon steel targets.

Shear fractures at approximately 45° to the circumference of the crater were also observed. Due to the high pressure in the crater, the metal in the jet was forced into the shear fractures.

The above observations indicate that it is possible to work-harden steel by explosives with lined cavities and also to spot-weld one metal on another. A full paper (by Singh, Krishnaswamy and Soundararaj) will be published shortly.

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The author is grateful to Professor D. S. Kothari for his interest and encouragement. Thanks are also due to Mr. N. R. Krishnaswamy and Mr. A. Soundraraj for their help in this work.

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ELASTIC CONSTANTS OF THALLIUM ALUM

ALUMS form an important group of cubic crystals which can be readily grown from aqueous solutions. The photoelastic behaviour of ammonium, chromium, potassium and thallium alums has been studied by Bhagavantam and co-workers.¹ The behaviour of thallium alum was observed to be quite different from that of other alums in that the photoelastic constant, q_{44} , of this substance is positive while the rest have a negative q_{44} . Elastic constants of ammonium potassium and chromium alums have been determined by Sundara Rao² and there is no data available in literature regarding the elastic behaviour of thallium alum. In the present investigation, elastic moduli (s_{ij}) of thallium alum have been determined using the composite piezoelectric oscillator method due to Balamuth³ and Rose.⁴

Specimen cylinders with their lengths along [100] and [111] directions are cut from a well-developed crystal grown in this laboratory. Young's modulus and rigidity modulus of these cylinders are determined in the frequency range 100-150 kc./s. and the elastic moduli are evaluated in the usual manner.

The results are given in Table I along with the data regarding the elastic behaviour of other alums. Elastic moduli are given in the units of 10^{-13} cm.² dyne⁻¹. Density of thallium alum = 2.32 g./cm.³

TABLE I

Substance	s_{11}	$-s_{12}$	s_{44}
Potassium Alum	51.8	15.3	116
Ammonium Alum	53.5	15.9	125
Chromium Alum	54.2	15.3	130
Thallium Alum	49.0	15.5	115

As can be seen from Table I, thallium alum falls in a line with other alums in its elastic behaviour.

The author expresses his grateful thanks to Professor S. Bhagavantam for his guidance and encouragement during the course of this work.

Physical Labs., S. V. SUBRAHMANYAM,
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WATER-MASSSES IN THE BAY OF BENGAL

THE earlier studies of water types in the Bay of Bengal were confined to the lower half of the Bay¹ and these do not appear to have been pursued after 1938. The classification of water-masses having definite limits of temperature and salinity has since become more comprehensive and includes new types.² In view of this a beginning was made towards a detailed survey of water-masses in the Bay.

With the co-operation of the Defence Ministry, the Andhra University arranged ocean cruises using Indian Navy Minesweepers for different studies relating to Bay of Bengal waters. During these cruises vertical temperature and salinity were taken at 21 stations along the east coast between Madras in the south and Swatch Of No Ground in the north. The study of water-masses in the western Bay was taken up during the Cruise No. 12 which was arranged from 4th to 6th March 1953. For this the requisite temperature and salinity data were selected at eight of the deeper serial stations. The temperature measurements were made with reversing thermometers and the salinity values are obtained by first determining the chlorinity of the samples, collected by Nansen bottles, by titration against standardised silver nitrate solution and then referring to Knudsen's tables. The investigation was confined to waters off the central east coast and observations made down to a depth of 500 metres wherever possible.

The surface and near-surface water-masses have recently been described.³ The names chosen for the shallow water-masses under study are those adopted by La Fond³ and are based on their origin, distribution, and formation. Their

designation is according to their density or σ_t . For example, the high-temperature low-salinity water having a $\sigma_t < 19.00$ is called Northern Dilute Water; $\sigma_t = 19.00-21.00$ Transition Water; $\sigma_t = 21.00-22.00$ Southern Bay of Bengal Water; $\sigma_t = 22.00-23.00$ Upwell Water; and $\sigma_t = 23.00-24.00$ Subsurface Shelf Water.

The Northern Dilute Water is formed in the northern part of the Bay of Bengal and is comprised of a large quantity of fresh-water discharged by the great rivers in that region. The heavier Southern Bay of Bengal Water is characteristic of the water at the surface at the south end of the Bay. Mixtures of the two are usually found somewhere in the Bay. The Upwell Water is found in spring adjacent to the coast, having upwelled from subsurface layers. The other still heavier water-masses never reach the surface.

The temperature and salinity limits vary widely in the surface layers, but must fall within the assigned σ_t limits. However, the

conventional deeper water-masses in the Indian Ocean² are more uniform having more restricted ranges of temperature and salinity. They are called Indian Equatorial Water, Indian Central Water, Red Sea Water, Antarctic Intermediate Water, Subantarctic Water, Circumpolar Water, and Antarctic Bottom Water.

On examination of the T-S diagrams (Fig. 1), constructed from the data collected in March 1953, the water-masses present can be identified. In this month the current off the east coast is flowing to the north-east. The Northern Dilute and Transition Water are not present now, having been dissipated by mixing with heavier water. The top stratum which extends down to 90 meters is composed of Southern Bay of Bengal and Upwell Water. Between 90 and about 160 meters is found the Subsurface Shelf Water and the Upper Limit of Indian Equatorial Water. The depths of the water-mass layers depend upon distance from shore and season.

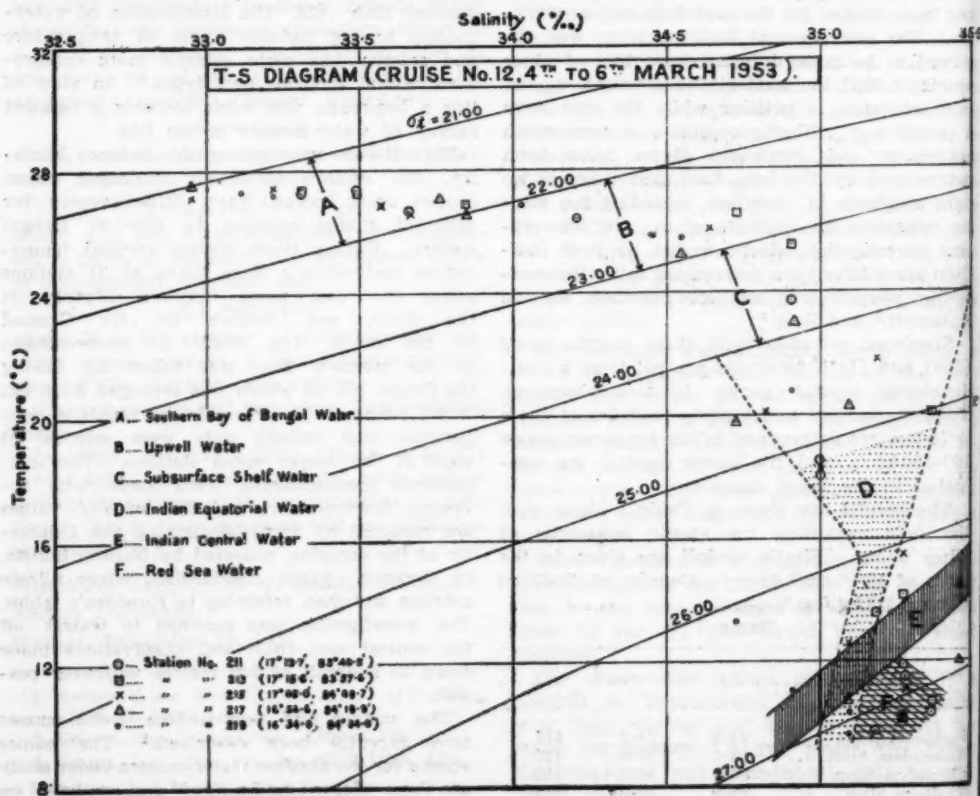


FIG. 1

The deep water-masses present, in addition to Indian Equatorial Water, appear to be Indian Central Water and Red Sea Water as shown in the figure by shaded bands.

The results arrived at are to be treated as tentative and more data are required to state precisely the nature of water-masses present and their characteristics. Study of the deeper waters is also called for, to understand more about the structure and circulation of the waters in the deeper layers.

The author is thankful to Prof. E. C. La Fond for guidance in the work.

Andhra University, C. POORNACHANDRA RAO.*
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* Now with India Meteorological Department, Poona 5.

NUCLEAR SCATTERING OF HIGH ENERGY ELECTRONS BY LIGHT ELEMENTS

THE nuclear elastic scattering of 125 Mev. electrons by beryllium has been observed by Hofstadter, Fechter and McIntyre,¹ while that of 190 Mev. electrons by beryllium has been observed by McIntyre, Hahn and Hofstadter.² Advani, Shah and Gatha³ have correlated these experimental relative differential scattering cross-sections on the basis of a characteristic nuclear form factor given by

$$g(\beta) = a_1 \exp(-\beta_1^2 \beta^2) + a_2 \exp(-\beta_2^2 \beta^2) / \{1 - \beta_3^2 \beta^2 + \beta_4^2 \beta^4\} \quad (1)$$

where

$$\begin{aligned} a_1 &= 0.0022 \text{ mb.}, \quad a_2 = 0.0078 \text{ mb.} \\ \beta_1 &= 0.29 \times 10^{-26} \text{ cm.}^2, \quad \beta_2 = 0.23 \times 10^{-26} \text{ cm.}^2 \\ \beta_3 &= 0.04 \times 10^{-26} \text{ cm.}^2; \quad \beta_4 = 0.0075 \times 10^{-32} \text{ cm.}^4 \end{aligned}$$

The above theoretical characteristic form factor has been obtained from the characteristic nuclear density distribution determined by Gatha and Shah,⁴ on the basis of the nuclear scattering of 340 Mev. protons. Recently Fregeau and Hofstadter⁵ have observed the nuclear elastic scattering of 187 Mev. electrons by carbon. The theoretical consequences of these observations have been considered in the present investigation.

It may be noted that the experimental observations on beryllium provide only the rela-

tive values of the differential cross-sections, while the experimental observations on carbon provide the absolute values for the same. Therefore, while the experimental values of $g(\beta)$ for beryllium are relative, those for carbon are absolute. It has been shown by Advani, Shah and Gatha³ that the experimental relative $g(\beta)$ for beryllium can be made to agree with the theoretical $g(\beta)$ after suitable normalization. The experimental absolute $g(\beta)$ for carbon can also be made to agree with the theoretical $g(\beta)$ by an appropriate renormalization. The theoretical $g(\beta)$ and such normalized experimental $g(\beta)$ are shown in Fig. 1 as represented by Curve A and the corresponding experimental points. It is clear that a satisfactory agreement, between the theoretical and normalized experimental $g(\beta)$, has been obtained. However, such a renormalization of the experimental absolute $g(\beta)$ for carbon presupposes that the original normalization is incorrect. In view of the original normalization process, used by Fregeau and Hofstadter,⁵ such an assumption appears untenable.

Assuming that the original normalization of experimental $g(\beta)$ for carbon is correct, the experimental relative $g(\beta)$ for beryllium have been normalized again so as to make all the experimental values of $g(\beta)$ to lie on a smooth curve. Such a curve, together with these values of experimental $g(\beta)$, are also shown in Fig. 1 by the curve B and the corresponding experimental points. It may be noted that the theoretical value of $g(0)$ is determined, irrespective of the nature of the charge density distribution, on the basis of its normalization only.

It is clear that $g(\beta)$, represented by curve A, is due to a characteristic nuclear proton density distribution which has been assumed to have the same form as the characteristic nuclear density distribution for nucleons. On the other hand, the $g(\beta)$ represented by curve B, must be regarded as due to a characteristic nuclear proton density distribution which may not have the same form as the characteristic nuclear density distribution for nucleons. It is considered unlikely at this stage, that the difference between $g(\beta)$ of curve A and $g(\beta)$ of curve B can be ascribed to any error in the determination of the characteristic nuclear density distribution for nucleons by Gatha and Shah.⁴ Thus, one has to ascribe this difference to an inherent difference in the characteristic nuclear proton density distribution and the characteristic nuclear density distribution for nucleons. This would mean that the characteristic nuclear

proton density distribution is different from the characteristic neutron density distribution for light elements.

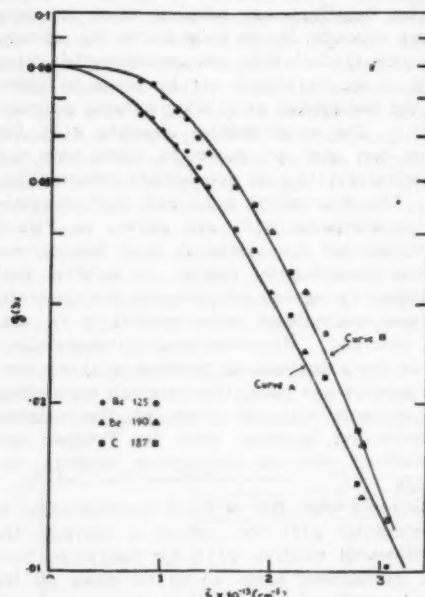


FIG. 1. Curve A represents theoretical $g(\xi)$ while the full points represent the experimental $g(\xi)$ normalized to it; Curve B represents experimental $g(\xi)$ normalized to carbon data while the open points represent the experimental $g(\xi)$ normalized to the same.

It may be noted that the form factor $g(\xi)$ for a point nucleus would be represented by the constant value $g(\xi) = 0.8$. Any deviations of $g(\xi)$ from this value must be regarded as due to the nature of the nuclear proton density distribution. It is clear that for small values of ξ , $g(\xi)$ of curve B deviates much less from this value than the $g(\xi)$ of curve A. It may also be noted that, in the Born approximation, $g(\xi)$ for small ξ arises from the characteristic nuclear proton density distribution at large distances from the centre of the nucleus. Therefore, one can conclude that the actual characteristic nuclear proton density distribution becomes negligible at smaller radial distances from the nuclear centre than the characteristic nuclear density distribution for neutrons. Therefore, the characteristic nuclear neutron density distribution predominates over the characteristic nuclear proton density distribution near the nuclear periphery. This conclusion agrees with that drawn by Johnson and Teller⁶ on the basis of the

nuclear β -stability. However, the conclusion arrived at in the present investigation should be regarded as tentative until confirmed by further experimental data and their analysis
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OCCURRENCE OF LIGNITIC MATERIAL IN THE GODAVARI DELTA

THE Government of Andhra have financed a project for the preliminary investigation of the occurrence of natural gas in parts of the Godavari Delta. Four bore-holes have been put down at Pedapatna Agraharam (150'), Vadrevupalle (100'), Amalapuram (200') and Thatipaka (325'), in the East Godavari District, between May and November 1955. Alternating layers of unconsolidated sand and clay were observed with occasional intercalations of partially decomposed vegetable matter. In the bore-hole at Thatipaka, blackish-brown fragments of low specific gravity (lighter than ordinary black clay) resembling peaty or lignitic material, were obtained at depths of 245' and 255'. The sample was analysed and the proximate analysis is given in column 1 of Table I. The usual range in composition of lignites, as specified by the U.S. Bureau of Mines, is also given alongside for comparison (col. 2).

TABLE I

	1	2
Moisture	.. 16-13%	23-20-40-00%
Volatiles	.. 40-05%	23-80-51-00%
Ash	.. 15-50%	4-20-15-80%
Fixed Carbon	.. 28-32%	20-90-35-00%

1. Analysis of Sample from Thatipaka, by T.V.S.R. Kshira Sagar. 2. Quoted from *Investigation of Preparation and Use of lignite*. U.S. Bureau of Mines, 1918-25, p. 86.

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It can be seen from the table that the composition of the analysed sample falls well within the range of lignites but for the moisture content, which appears to be rather low. Detailed work on the nature of the sediments in the delta area is under progress.

The authors are grateful to Dr. V. S. Krishna for encouragement, to Professor C. Mahadevan and Dr. A. N. Rao for guidance and criticism and to Dr. M. N. Rao for help.

T. V. S. R. KSHIRA SAGAR.
B. B. G. SARMA.

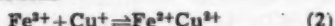
Dept. of Geology,
Andhra University,
Waltair, December 29, 1955.

ON THE ESTIMATION OF IRON BY IODOMETRY

The overall reaction involved in the estimation of iron by iodometry is represented by



A common practice¹ is to use suspensions of Cu_2I_2 to catalyse the liberation of iodine. The use of this catalyst in effect provides an alternative mechanism in eliminating or modifying any of the steps suggested by Fudge and Sykes.² As a matter of fact, it can be noticed that on addition of a small quantity of Cu_2I_2 to the solution of ferric salt, iodine is liberated and a transparent solution is obtained. Evidently the reactions



come into play. The full implication of reaction (2) in the ferric iodide reaction as well as in the oxidation of HI in the solution phase³ will be published in due course.

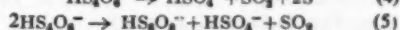
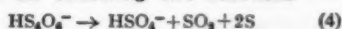
In spite of extensive investigation,⁴⁻⁸ this method still presents difficulties preventing its wide application. We prescribe the conditions for an accurate estimation of iron present in solution as chloride, nitrate, perchlorate and even as sulphate, upto 0.3 molar concentration of Fe^{3+} having corresponding initial acid strength of 0.1N. Use of HClO_4 has been recommended as HNO_3 and HCl often contain impurities that affect the accuracy of the result. Complex formation with Cl^- and SO_4^{2-} ions do not affect the accuracy of the method. The reaction is complete within 2 minutes at room temperature. The necessity of using any catalyst or maintaining CO_2 atmosphere does not arise.

In consideration of the observation of Kiss and Bossanyi⁹ and the various side equilibria inherent in the system, we have so adjusted

the concentrations of H^+ and I^- such that for a range of Fe^{3+} ion concentration iodometry can give satisfactory results.

To 25 c.c. of the solution of the ferric salt of strength ranging from 0.1-0.3 M containing initially 0.1 N acid, 2 c.c. of 6N HClO_4 and 4 g. of solid KI are to be added. The titration is to be carried out as usual with 0.1N $\text{Na}_2\text{S}_2\text{O}_3$ solution using starch as indicator. The end point is sharp and after-blueing does not occur for days. For solutions of low Fe^{3+} content, the amount of solid KI should be maintained while 1 c.c. of acid is to be added and titration with 0.05 N or 0.025 N solution of $\text{Na}_2\text{S}_2\text{O}_3$ as necessary may be carried out. After-blueing of starch would not occur for at least 20 minutes, though the time allowed for the liberation of iodine is 2 minutes and that for titration 3-4 minutes.

The non-occurrence of after-blueing has been found to be dependent on the concentration of HS_2O_6^- which gives SO_2 on decomposition. Of the following two reactions



We are of opinion that reaction (5) takes place predominantly in the presence of Fe^{2+} and HI in the system as sulphur does not appear in any considerable quantity. The formation of SO_2 does not allow the appearance of after-blueing. With lapse of time, when the decomposition is either complete or the rate of aerial oxidation of Fe^{2+} and HI is greater as compared to the combined rate of reactions (4) and (5) that the after-blueing appears. The iodometric method of estimation entails various factors contributing to positive and negative errors,³ but the procedure prescribed above gives results which are as accurate as obtained by dichromate method using N-phenyl anthranilic acid as indicator.

Dept. of Chemistry,
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BENZON CONDENSATION OF SALICYL ALDEHYDE

SALICYLALDEHYDE has been treated with potassium cyanide in ethyl alcoholic solution, using the usual proportions.¹ Contrary to expectations, salicylaldehyde also appears to undergo the benzoïn condensation. The reaction proceeds smoothly, even at room temperature and within half an hour (usually benzoïn formation requires refluxing for about 1½ hours on a steam-bath), the colour changing through yellow and orange to brown product obtained by refrigeration. The benzoïn when purified by recrystallisation from alcohol and acetic acid, yielded reddish brown needles, m.p. 148-50° C., decomposing at 186-88° C. (Found: C, 68.7; H, 4.8; C₁₄H₁₂O₄ requires C, 68.85; H, 4.92.)

The easy synthesis of this benzoïn is probably due to the ortho-effect operating in salicylaldehyde, which, aided by the electrometric effect, facilitates the release of proton. This work was conducted at the R.P.D. College, Belgaum.

Technical Dept.,
Stan-Vac Refineries, Bombay,
October 27, 1955.

R. J. PHADKE.

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PEROXY TITANIUM OXALATE

MAZZUCHELLI AND PONTANELLI¹ prepared a peroxy titanium complex of the formula Ti₂O₃(C₂O₄)₂ which can be considered as a derivative of Ti₂O₃, but the normal peroxy titanium oxalate (TiO₂C₂O₄) has not been prepared so far. The work carried out in this laboratory has yielded practically pure peroxy oxalate as outlined below.

The slurry of freshly precipitated titanic acid was mixed with excess of hydrogen peroxide and oxalic acid in the molar ratio of 1:3:3 when a red solution was obtained. This solution was evaporated by passing dry air when oxalic acid crystals separated. The mother liquor on further concentration yielded an orange-red amorphous solid which was washed with absolute alcohol to remove the uncombined oxalic acid and hydrogen peroxide. The washed product was then dried free of alcohol by dry air and analysed for titanium, oxalate, peroxy oxygen and water. The titanium, oxalate and water contents were determined by combustion method while peroxy oxygen was determined by treating the substance with acidified potassium iodide and estimating the

iodine liberated. The analyses of the samples prepared in this way are given in Table I.

TABLE I

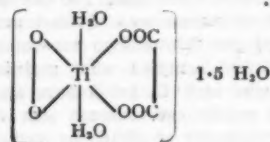
Experiment No.	Reactants in the aqueous mixture (mole ratio)			Molar composition of the complex				
	Ti(OH) ₄	H ₂ O ₂	H ₂ C ₂ O ₄	Ti	O*	C ₂ O ₄	O†	H ₂ O
1	1	2.90	2.92	1.00	1.00	1.10	0.98	3.40
2	1	2.98	3.00	1.09	1.00	1.10	0.97	3.42
3	1	3.02	3.10	1.08	1.00	1.09	0.93	3.40
4	1	2.00	2.90	1.52	1.00	1.51	1.41	5.50
5	1	0.62	2.90	2.09	1.00	2.03	1.95	6.08

* Peroxy oxygen by KI method; † Oxygen by difference.

The results of Table I (Expts. 1 to 3) show that the composition of the complex is practically TiO₂C₂O₄·3.5H₂O when three moles of H₂O₂ are employed. It is further seen that when the amount of hydrogen peroxide in the starting solution is less (Expts. 4 and 5) complexes of the formulae Ti_{1.5}O_{2.5}(C₂O₄)_{1.5}·5.5H₂O and Ti₂O₃(C₂O₄)₂·7H₂O are obtained. The latter complex is identical with the complex prepared by Mazzucchelli and Pontanelli.¹ Thus it is essential to maintain high concentration of H₂O₂ to get the normal peroxy complex TiO₂C₂O₄·3.5H₂O.

Physico-chemical studies like molecular weight, conductivity, vapour pressure, absorption spectra, potentiometric titration against alkali, dehydration and decomposition under reduced pressure, show that the complex Ti₂O₃(C₂O₄)₂ and other complexes of lower peroxy oxygen content are mixtures of TiO₂C₂O₄ and TiOC₂O₄. The molecular weights of the complexes (Expts. 1 to 3) were found to be 230 ± 4 by the freezing point method. The average dissociation constant for the normal peroxy complex as found by the conductivity method was 4.5 × 10⁻². The determination of aqueous tension at different temperatures gave a value of 15.39 k. cal./mole for the heat of dissociation of the complex. The complex has a characteristic absorption maximum at 425 mμ. Potentiometric titrations show that the complex is dibasic. Dehydration of the complex shows that out of 3.5 moles of water, 2 moles are not removed by dehydration in vacuum over P₂O₅. The complex loses active oxygen on storage. From the physico-chemical studies

indicated above it is concluded that the formula of the complex is



The authors are grateful to Prof. K. R. Krishnaswami and Dr. M. R. A. Rao for their keen interest and advice.

Dept. of Gen. Chem.,

Indian Inst. of Sci.,

Bangalore-3, November 22, 1955.

D. P. KHARKAR.

C. C. PATEL.

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ANTIBIOTIC PRINCIPLE OF THE LEAVES OF *WITHANIA SOMNIFERA**

DURING a routine screening of Indian medicinal plants used in *Ayurveda* for the treatment of bacterial infections, it was found that the roots and leaves of *Withania somnifera* (Sanskrit: *Aswagandha*) exhibited marked activity against *S. aureus*. Alcoholic extract of the fresh leaves showed much more activity than the roots and was therefore taken up for detailed investigation. The ground root and leaves are in use in *Ayurveda* among its many other applications, for the treatment of carbuncles, ulcers and painful swellings. An essential oil, ipuranol, a crystalline alcohol withanol, hentriacontane, phytosterols and fatty oils are known to be present in the plant along with 3 alkaloids one of which somniferin C₁₂H₁₈N₂, is crystalline.¹

Fresh leaves were extracted at room temperature with absolute alcohol for 24 hours, and the extract evaporated to dryness in a desiccator over anhydrous calcium chloride in the refrigerator. The residue was taken up first in small quantities of acetone and then with absolute alcohol and the two extracts combined. A resinous material, insoluble in both these solvents, was left behind, which was devoid of any activity. A small quantity of the solution which contained the activity was spotted on a strip of Whatman No. 1 filter-paper, 30 cm. × 2.5 cm. and a chromatogram run at 0°C. by the ascending method, using ether saturated with water, as the solvent system. The chromatogram was dried at room

temperature, cut into smaller bits (both horizontally and vertically in the middle) and put on seeded agar plates (seeded with a 24-hour-old culture of *S. aureus*) and incubated at 37°C. for 18 hours. A duplicate chromatogram was also run under identical conditions, dried and kept apart. There were two zones of inhibition on the seeded agar plate, one of smaller activity (diameter of the zone of inhibition was 8 mm.) with very low Rf value (0.06) and the other of marked activity (diameter of the zone of inhibition was 40 mm.) with an Rf value of 0.786 (Fig. 1).

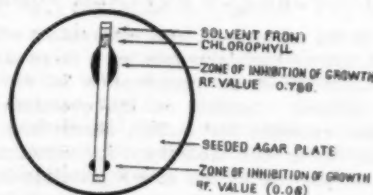


FIG. 1

The portions corresponding to the two active zones were cut off in the duplicate chromatogram, eluted separately with a mixture of acetone and alcohol (1:1). The solutions showed negative test with alkaloidal reagents (potassium mercuric iodide and tannic acid; a drop of the reagent was mixed with a drop of the solution on a slide and examined under the microscope) thus showing that the activity is not associated with any alkaloids of the plant.

The more active substance (Rf value 0.786) was isolated from the alcoholic extract of the leaves in a chemically pure state. It was a pale yellow crystalline solid (yield: 5 mg. from 100 g. of fresh leaves) melting at 213-15°C., soluble in alcohol, acetone, benzene and ether; neutral to litmus and gave a yellowish colouration with ferric chloride solution. It completely inhibited the growth of *S. aureus* (strain obtained from the Central Institute of Research, Kasauli and maintained in our laboratory) at a dilution of 1 in 600,000 when assayed by serial dilution method using buffered nutrient broth (phosphate buffer of pH 7), while there was partial inhibition of growth even at 1 in 1,000,000. A dilution of 1 in 1,000 of a 24-hour-old culture was used. The substance was not inactivated by heat. It was more stable on the acid side, but was slowly inactivated on the alkaline side. Details of the method of isolation and other data are being published

* Published with the kind permission of the Governing Body, C.I.R.I.S.M.

elsewhere. Detailed investigations on this substance are in progress.

My sincere thanks are due to Dr. C. G. Pandit and Dr. P. M. Mehta for their keen interest in this work.

Dept. of Biochemistry, P. A. KURUP.
Central Inst. of Research,
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DILUTORS FOR BUFFALO SEMEN

ONE of the major problems confronting efficient utilisation of buffalo semen on a large scale is the difficulty of its preservation *in vitro* for long periods. Studies on the evolution of a suitable extender for buffalo semen are being carried on in our laboratory for sometime. A note on the use of the active principle instead of the whole egg-yolk was communicated in these columns earlier.¹ Subsequent researches have revealed certain inherent difficulties in the general use of the active principle as a substitute of egg-yolk. First is the cost, and second the loss of activity of the separated powder under purification and storage.

Recently, a detailed study was undertaken with six dilutors. They were: (i) active principle (PA), (ii) egg-yolk phosphate (EyP), (iii) egg-yolk citrate (EyC), (iv) autoclaved milk (AM), (v) "Spermasol" (S)—a proprietary product of Messrs. H. Mack of Illertissen, W. Germany, and (vi) glucose-soda bicarbonate-sulphamezathine (I.C.I.)-egg-yolk (G). Kumaran² used a dilutor similar to (vi) but containing sulphamethazine (Sulphadimidine sodium 16% W/V solution). Preliminary trials showed that the dilutor so prepared was in no way better than (iii), i.e., EyC. The poor keeping quality of Kumaran's dilutor might be due to the high pH value (10.5 to 11) of the sulphamethazine sodium solution added to the dilutor, whereas aq. solution of the powder form at 37° C. gave a pH of 6.65. The dilutor used by the authors contained sulphamezathine (I.C.I., sulphadimethylpyrimidine) in the powder form. It contained four parts of 5% glucose containing 2 g. sulphamezathine (I.C.I.) per 100 ml. + 1 part of 1.3% soda bicarbonate solution + 1 part of egg-yolk. The rest of the dilutors were prepared as usual except "Spermasol" which was prepared as per directions accompanying the ampoules. The rate of dilution was kept constant (1:5).

The results obtained are given in Table I. Only ejaculates showing not less than 90% live spermatozoa were used for the trials. A given sample of semen was divided among the dilutors and per dilutor two sub-samples were run. The diluted samples were maintained in thermos flasks at 4° C. for 8 days and the percentage of motile spermatozoa was estimated in a haemocytometer at 37° C. by using a microscope equipped with a thermostage.

TABLE I

Dilutor	Bull No.	No. of ejaculates tested	No. of ejaculates in which all sperm died on the 8th day	Average % of live sperm
PA	28	5	4	1.0
	33	5	3	1.3
	24	6	4	10.9
	25	3	2	2.1
	Total	19	13	3.8 (Av.)
EyP	28	5	4	5.0
	33	5	4	6.7
	24	6	3	10.5
	25	3	2	3.0
	Total	19	13	6.3 (Av.)
EyC	28	5	3	9.7
	33	5	3	19.0
	24	6	1	27.2
	25	3	1	21.2
	Total	19	8	19.3 (Av.)
AM	28	5	2	15.5
	33	5	3	1.0
	24	6	4	15.1
	25	3	2	13.6
	Total	19	11	11.3 (Av.)
S	28	5	1	16.7
	33	5	0	36.2
	24	6	1	30.3
	25	3	0	30.5
	Total	19	2	28.4 (Av.)
G	28	5	0	16.6
	33	5	0	49.7
	24	6	2	22.0
	25	3	0	42.2
	Total	19	2	32.6 (Av.)

From Table I, it is clear that among the dilutors for buffalo semen tried, G is the best followed in order of decreasing suitability (on efficiency) by spermasol, EyC, AM, EyP and PA. Further, the results indicate a bull to bull variation in the "preservation index" by which is meant the capacity to survive *in vitro*.

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Fertility trials carried on under controlled conditions revealed rates as favourable with 'G' as with EyP/EyC. However, further trials are considered necessary to confirm this finding.

Recently, preliminary trials carried out with 'G' and glycine egg-yolk dilutor developed by Roy and Bishop³ showed that the latter was not superior to the former as far as buffalo semen *in vitro* was concerned. Twelve ejaculates from two buffalo bulls preserved in G and glycine egg-yolk dilutor showed average motility ratings of 2.38 ± 0.31 and 2.38 ± 0.18 respectively after a lapse of 7 days. Further work is in progress.

We are thankful to Messrs. Mack & Co., for the supply of Spermasol for trials.

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I.V.R.I., Izatnagar, U.P., S. S. PRABHU.
August 19, 1955.

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A NEW REAGENT FOR GRAVIMETRIC ESTIMATION OF IRON

THE use of diphenyl thio-violuric acid for the gravimetric estimation of copper was reported by the author in two communications recently.^{1,2} In the course of the present investigation, it was found that this reagent can also be used for the gravimetric estimation of iron. Iron can be estimated both in ferrous and ferric condition by this reagent, two different compounds being precipitated in the two cases.³ For these estimations, the ammonium salt of diphenyl thio-violuric acid was used.

With the pH controlled between 4.9 and 5.6 in the case of ferrous iron and 4.9 and 5.8 in the case of ferric iron, an excess of the reagent was added (thrice the amount with ferrous and twice with ferric). Complete precipitation could be effected after warming the reagents together on a water-bath for an hour and leaving the product overnight. Filtration through sintered crucibles (porosity 4) and drying at 110° gave constancy of results with an accuracy of 0.2-0.3%.

Dept. of Chemistry,
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Delhi-8, December 8, 1955.

R. P. SINGH.

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ECHINORHYNCHOTAENIA LUCKNOW- ENSIS N. SP. (HYMENOLEPIDIDAE: CESTODA) FROM DARTER, ANHINGA MELANOGASTER PENNANT

A NEW cestode *E. lucknowensis* is described from darter bird, *Anhinga melanogaster*. The parasite measures 278 mm. in length and 4.5 mm. in maximum breadth. The scolex measures 0.4-0.43 mm. by 0.28-0.32 mm. The rostellum is 0.3-0.415 mm. in length and is armed throughout its length with numerous small spines, 0.011-0.012 mm. in length. The suckers are unarmed. Each proglottid has three testes: two posterior and one anterior and aporal, thus triangular in position. The cirrus pouch extends one-third across the proglottid. The cirrus is muscular and armed with small spines at the base. A large receptaculum seminis is present and the uterus is sac-like, extending beyond the longitudinal excretory ducts. Rest of the genital organs are typically hymenolepid. Certain variations in the position of the testes and genital pores are also recorded.

The genus possesses two species: *E. tritesticulata* Fuhrmann, 1909 (Africa)^{1,2} and *E. nana* Maplestone and Southwell, 1922 (Australia).³ The present form differs from both these species mainly in the position of the testes. This appears to be the first record of the genus *Echinorhynchotaenia* Fuhrmann, 1909, from India.

The full description of this new species is being published elsewhere.

My thanks are due to Dr. Kr. S. Singh for his guidance.

Dept. of Zoology,
The University, Lucknow,
December 1, 1955.

K. P. SINGH.

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OCCURRENCE OF TWO WOOD-BORING PHOLADS AT MADRAS

PREVIOUS workers²⁻⁵ have recorded only *Mar-tesia striata* in India. However, in a recent survey of wood-boring pholads of Madras Coast, *M. (M) fragilis* was collected from catamarans and fishing boats from the open sea, and has not been met with inside the harbour area where *M. striata* abounds. Identification

was confirmed by Dr. Ruth Turner of the Museum of Comparative Zoology, Harvard University, who is of the opinion that this is pelagic in habit even in the West.

In view of the importance of *M. fragilis* as a pest of catamarans and fishing boats, a brief preliminary account of this species is given here.

In this pholad as well as in *M. striata*, identification is rendered difficult because, (i) the callus is developed as the young grows into the adult, and (ii) the dorsal plates of the mesoplax are double in the young form and become fused in the adult. These facts brought to light by Turner⁶ necessitated *Martesia* (*Diploplax*) *americana* and *M. (Diploplax) funisicola* as well as *M. (Diploplax) exquisita* and *M. (Diploplax) bahamensis* which were treated as distinct species by Bartsch and Rehder¹ being brought into *M. striata* and *M. fragilis*.

Owing to the great similarity between the two species (*M. striata* and *M. fragilis*) in these respects, distinction between the two can be made only on the basis of the dorsal plate of the mesoplax bearing concentric lines in *M. fragilis* and the dorsal plate being irregularly wrinkled in *M. striata*. Among other features of difference the following may be mentioned: The umbonal reflection is more pronounced in *M. fragilis* since it is twice the thickness of what is found in *M. striata*. The shells of *M. fragilis* are smaller and more delicate (ranging from 6-18 mm.) than the shells of *M. striata* (ranging from 6-36 mm.). It is possible therefore to distinguish shells beyond 18 mm. in length as those of *M. striata*.

Our grateful thanks are due to Prof. C. P. Gnanamuthu for his valuable guidance during this study.

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OCCURRENCE OF A MERMETHID WORM PARASITE ON HELOPELTIS THEIVORA WATERHOUSE

In the course of investigation of tea-insect pests, we came across several specimens of *H. theivora* heavily infested with the mermethid parasitic worms. This is of considerable importance because so far no effective natural enemy of this insect pest has been reported. Mermethid infection of insects is not uncommon.^{1,2} But such infestation of *Helopeltis* was not previously reported. It opens the possibility of biological control of the tea-bug in tea plantations.

Helopeltis theivora sporadically breaks out into a pest causing serious damage to tea plantations. The cause of sudden appearance and disappearance of the pest, however, remains a mystery.^{3,4}

The specimens of *H. theivora* infested by the mermethid species were obtained from Kantaguri Tea Estates in the Jalpaiguri District of West Bengal, during the months of July and August 1946, which coincided with the rainy season. The hosts showed no external visible sign of infestation until the viscera of the insect was examined. In a collection of insects comprised of five males, six females and nine nymphs at the 3rd, 4th, 5th instars, numbering twenty in all, eight specimens comprised of two



FIG. 1. Photomicrograph of the mermethid worm around the viscera of *Helopeltis theivora*.

males, three females and three nymphs at 3rd instars were found parasitized by the worm. In each insect a single juvenile worm was found. The largest worm was 7 cm. in length and 0.3 cm. in diameter, and the smallest measures 5 cm. in length. The worm was found in the hæmocoelic cavity of the abdomen entwining the general viscera of the insect (Fig. 1). The anterior end of the worm was found attached to a small conical growth on the midgut of the insect (Fig. 2). In normal anatomy of this

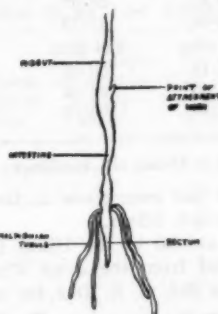


FIG. 2. Deformed gut of the parasitized *Helopeltis theivora*.

insect, such a cone formation is not found, and evidently this was a pathological growth as a result of mermethid infection. Other organs of the host also suffer degeneration. The salivary glands of the adult insect became reduced in size and were pale white in colour instead of brown. The midgut was very much reduced in size with narrowing down of its lumen, feeble development of circular and longitudinal mus-



FIG. 3. Degeneration of ovarioles in the parasitized *Helopeltis theivora*.

cles and the absence of secretory granules in the epithelial cells. The intestine became short and straight, the intestinal coils being lost and fat bodies disappeared or disintegrated into granules.

Reproductive organs of both male and female insects showed remarkable degeneration, ovarioles were reduced in number and ceased to produce eggs. The egg chambers became indistinct. In one specimen the normal number of ovarioles which is seven, persisted on one side, while on the other side it was reduced to two (Fig. 3). However, the spermatheca and the accessory glands were not much affected. In males, the testes with ducts atrophied and disappeared. The ejaculatory duct, however, persisted as in normal. The external appearance of the parasitized insect was not much affected. Wings, mouth-parts and legs remained as in normal.

We have pleasure in thanking the Indian Tea Planters' Association, Jalpaiguri, for financing the scheme and giving us all facilities for field work.

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SAMBHUNATH RAYCHOUDHURI.*

Entomology Lab.,
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October 6, 1955.

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PHOTOPERIODIC BEHAVIOUR OF "THAILAND"—A PHILIPPINE VARIETY OF RICE

PHOTOPERIODIC studies has been carried out with rice of different countries of the world¹⁻⁶ with varied results. The present investigation aims at finding out the photoperiodic behaviour of a variety of rice, "Thailand", of Philippines procured from the Central Rice Research Institute, Cuttack. The grains, after a preliminary selection for uniformity, were soaked in water and, when visible germination was observed, were sown on December 21, 1953, in earthenware seed-bed pots containing well mixed soil and cowdung manure mixture in the proportion of 9:1 parts by volume. Seedlings 35 days old were transplanted on January 25, 1954, to bigger-sized (10" × 10") earthenware pots

TABLE I
(Average figures of 24 plants)

		21-2-1954	2-3-1954	16-3-1954	Ear-bearing tillers
Number of tillers per plant	A	1.54	2.37	5.17	5.00
	B	3.25	3.54	5.87	5.77
	C	4.58	6.45	6.75	5.68
Number of green leaves per plant	A	6.87	10.58	16.73	
	B	12.25	14.87	20.04	
	C	16.45	26.79	25.08	
Height per plant in cm.	A	31.25	40.25	61.00	
	B	40.81	49.35	66.07	
	C	40.22	50.60	57.73	
Time from sowing to ear emergence in days		Main shoot	1st tiller	2nd tiller	
	A	96.30	99.15	100.50	
	B	96.52	98.56	99.54	
	C	101.54	104.28	106.04	

A—Short photoperiod to 40-day old seedlings; B—Short photoperiod to 55-day old seedlings; C—Controls.

at the rate of 8 seedlings per pot. After a week, the plants were thinned down to 4 per pot. Short photoperiods of 8-hour duration in a 24-hour cycle were given to 40-day-old seedlings for 40 days in one set and to 55-day-old seedlings for 40 days in another set. A third set was all along maintained under the normal day length as controls. The data pertaining to the formation of tillers, leaves and the height of the plant were collected at intervals and finally the number of ear-bearing tillers and the duration of the vegetative period from sowing to ear emergence, were recorded and are presented in Table I.

A study of Table I brings out the following salient points:

(i) Tillering has been greatly retarded under the influence of the short day, the effect being much more conspicuous when the treatment was given at the earlier age of 40 days. (ii) The formation of leaves has been adversely affected exactly as the tillers as a result of the short-day treatment. (iii) The height of the plant has been inhibited only in the case when the short photoperiods were given to 40-day-old seedlings. The inhibiting effect is operative as long as the short days are given. So, at the final stage when the short days have been discontinued, there has been an increase in height. In the set which received the short photoperiods at 55th day, there is no marked difference from the controls except at the final stage when the plants attain a much greater height than the controls. (iv) With regard to the effect of short days in the matter of time taken to ear emergence it is seen that short photoperiods for 40 days to 40-day and 55-day-old seedlings brought about a signi-

ficant earlier ear emergence in the main shoot, first and second tillers.

We are thankful to the Utkal University for a grant-in-aid from the Jnan Vijnan Parishad Fund, and to Sri. J. K. Das for assistance.

Dept. of Botany,
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Cuttack-3, November 3, 1955.

B. SAMANTARAI
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LIFE-HISTORY AND HOST RANGE OF *PRODECATOMA PONGAMIAE* MANI AND KURIAN (HYMENOPTERA—FAMILY EURYTOMIDAE)

THE Hymenopterous parasite *Prodecatoma pongamiae* was newly recorded and its taxonomic characters described by Mani and Chandy Kurian only recently.¹ However, details regarding the biology of the parasite and its host range yet remain to be investigated. Recently, at Dharwar while working out the seasonal life-history of "udid" (*Phaseolus mungo*) weevil pest—*Aptin* sp., a considerable number of the grubs were found parasitised by the above parasite. The incidence of the parasite in nature during September and October 1955 ranged between 19.0 to 25.3 per cent. Since the details regarding the life-history of the parasite *P. pongamiae* with reference to any host insects have not been worked out previously, the information is summarised below.

Details of the life-history of the parasite *P. pongamiae* with reference to one host insect are given in Table I. The parasites were reared in the laboratory between 6-9-1955 to 30-9-1955. In all the rearings carried out at 78.5° F. mean temperature and 91.4% humidity, only a single adult parasite developed from a host grub. Further details regarding the different life-stages of the parasite are given in Table I.

TABLE I

Showing the life-history of *P. pongamiae* in relation to its host *Apion* sp.

S. No.	Pre-oviposition period in days	Post-embryonic developmental period in days	No. of adult parasites emerged from each host	Duration of life of adults in days
1	3	4	1	3
2	3	4	1	4
3	2	5	1	4
4	3	5	1	3
5	3	4	1	4
6	2	5	1	3
7	2	5	1	4
Average	2.5	4.5	1.0	3.5

In all the cases, the host grubs of 3-4 days old only were selected by the parasite for the purpose of oviposition. The prepupal stage of the host grub escaped parasitisation even under artificial inoculations. In nature parasites exhibited sharp instinctive powers for locating the host grubs developing within the seed pods. The average life-history of the parasite in relation to the host *Apion* sp. worked out to be 7 days.

Entomological Lab., H. L. KULKARNY.
College of Agriculture, N. L. HALLEPPANAVAR.
Dharwar, October 27, 1955.

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FURTHER STUDIES ON *SCILLA HOHENACKERI* FISCH. & MEY.

A SHORT note dealing with the somatic chromosomes of *Scilla hohackeri* was published previously in this journal.¹ Further study with the application of improved technique has not only confirmed the previous observations but revealed certain additional features in the morphology of chromosomes of this species. The technique employed during the present investigation involves a pre-treatment of root-tips with α -bromo-naphthalene for 2 hours followed by a fixation in a mixture of Benda and

0.001 mol. oxyquinoline at 8-10° C. Feulgen squash preparations were made with such root-tip material.

As will be seen from Fig. 1, the diploid chromosome complement of *Scilla hohackeri*



FIG. 1. Photomicrograph of the somatic metaphase of *Scilla hohackeri* showing 10 chromosomes, out of which 4 medium-sized chromosomes are characterised by heterochromatic segments, \times about 1,500.

($2n=10$) consists of: (i) two pairs of long chromosomes, one with median and the other with submedian primary constrictions; (ii) two pairs of medium-sized chromosomes of variable lengths, each with a subterminal primary constriction and a secondary constriction in the short arm very close to the primary one; (iii) one short pair of chromosomes with a subterminal primary constriction and two secondary constrictions in the long distal arms. The proximal arms of this pair are knob-like and are devoid of secondary constrictions unlike the previous pairs.

One of the outstanding features of the karyotype is the presence of heterochromatic segments at the distal ends of the medium-sized chromosomes. No other chromosome type showed the same. Very careful search has revealed no such segments in the intercalary parts of any of the chromosomes in the complement (except perhaps at the primary insertion regions, where it is presumed to be always present). Even if present, they are certainly not visible under microscope. Hence, the terminal location of heterochromatin in the chromosomes of *Scilla hohackeri* appears to have some adaptive significance.

Furthermore, a study of about 100 metaphases from 9 bulbs showed that the number of medium-sized chromosomes carrying heterochromatic segments vary consistently from plant to plant in *Scilla hohackeri*. Some plants are characterised by chromosomes with no heterochromatic segments and others showed 1-4 such chromosomes. Whenever they are 4 in number, one pair has very short and the

other fairly long heterochromatic segments. Such plants with 4 segments were found to be more vigorous in growth than the rest. It is therefore inferred that the physiological effect of variation with regard to the extent of heterochromatic material in different individuals of *Scilla hohensekeri* may be similar to that of supernumerary chromosomes within a species population.

Dept. of Botany,
University of Sagar,
Sagar, M.P.,
November 8, 1955.

Y. SUNDAR RAO.

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TECHNIQUE FOR ARTIFICIAL INOCULATION OF COTTON PLANTS WITH *MACROPHOMINA PHASEOLI*

Root rot of cotton incited by *Macrophomina phaseoli* (Maubl.) Ashby is a major disease of cotton in Bombay State especially in the *Goradu* soils of Gujarat. Uptil now for lack of proper inoculation technique for obtaining infection under controlled conditions in the laboratory, all the studies on cotton root rot by different investigators have been based on naturally infected plants in the field. In the present study, the disease was artificially produced in the laboratory under pot culture tests. The fungus which could easily be isolated on potato dextrose agar from diseased specimens grew very rapidly at 30° C. producing greyish cottony-white mycelium. The following technique was successfully adopted in producing 100% infection.

10-45-days old cotton seedlings raised in sterilised soil in 6" pots were used for inoculation purposes. The fungus was grown on corn-meal sand medium in large sterilized kilner jars. After 24, 48 and 72 hours incubation at 30° C., the mycelial mat was carefully scooped with the help of a sterilized spatula taking care that no mycelial strands were damaged. This inoculum was placed in close juxtaposition with the roots by lifting little soil near the root. The fungus was allowed to remain undisturbed *in situ* by covering it with a light soil layer. The inoculated pots were incubated at 28° C. and several uninoculated plants served as controls. The watering of pots was done twice a day taking care that excess of watering was avoided. It was noticed that plants inoculated with 48-hour old culture showed maximum death rate. This is probably because the evanescent mycelium breaks down forming sclerotial bodies as it grows older.

This finding is in conformity with that reported by Thirumalachar¹ who obtained similar results with charcoal rot of potato. The inoculated plants suddenly droop down on the 3rd or 4th day after inoculation (Fig. 1). Such

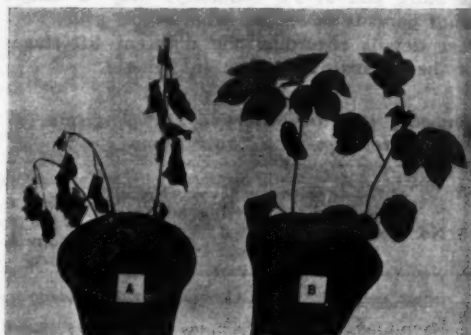


FIG. 1. A—Diseased; B—Control.

plants when uprooted showed completely damaged condition of lateral root system. The bark of such plants could easily be peeled off leaving brown discolouration of the exposed area which was densely covered with sclerotial bodies. The diseased plants on re-isolation yielded the original fungus which on re-inoculation proved equally pathogenic. Besides cotton, the fungus was found equally pathogenic to *Dolichos lablab* L., on which was found characteristic persistent fumaceous mycelium with irregularly formed sclerotial bodies.

Further work is in progress.

L. MONIZ.

M. J. THIRUMALACHAR.

M. K. PATEL.

Plant Pathological Lab.,
Agric. College, Poona,
December 2, 1955.

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STUDIES ON *SORGHUM NITIDUM* PERS.

THE chromosome numbers of *Sorghum nitidum* collected at Rangaswami Hills and at other places between elevations of 3,500-5,000' were found to be $2n=20$.¹ Subsequently, collections made from other places gave plants with $2n=10$ chromosomes. The habitats and plant associations were similar for these two chromosome forms. Morphologically also they are similar. While the 20-chromosomed plant grows to a height of 10' the other attains only 4-5'. Since this is the first record of the occurrence

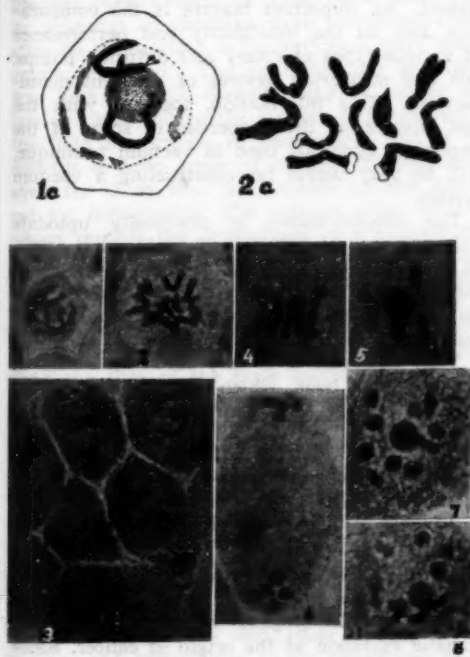
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of the 10-chromosomed form of the species a brief account of its behaviour is reported below.

Somatic chromosomes as determined in root tip preparations are large, and more or less equal in length. There are four median, four submedian and two subterminal constricted chromosomes. The nuclear chromosomes are two, satellited and subterminally constricted (Figs. 1, 1 a, 2, 2 a). The meiosis as observed



FIGS. 1, 2, 4, 5, 7 and 8 = $\times 1,400$; FIGS. 1 a and 2 a = $\times 3,110$; FIG. 3 = $\times 585$; FIG. 6 = $\times 1,120$.

FIGS. 1 to 6. *S. nitidum* ($2n=10$)—1. Somatic prophase showing satellited nucleolar chromosomes; 1 a. Camera lucida drawing of the microphotograph; 2. Somatic metaphase plate. 2 a. Camera lucida drawing of the same; 3. Diakinesis showing one bivalent attached to the nucleolus; 4. metaphase (5_{11}); 5. Anaphase; 6. telophase with 5-5 distribution; FIGS. 7 and 8. Diakinesis of 20-chromosomed form with one nucleolar bivalent in Fig. 7 and a probable two in Fig. 8.

in acetocarmine smears is normal giving five bivalents. The nucleolar chromosomes form a bivalent. The metaphase is compact with a normal bipolar spindle. The telophasic distribution is regular giving 5-5 at poles (Figs. 3 to 6).

The meiosis of the 20-chromosomed form shows in all P.M.C.s only a single bivalent found attached to the nucleolus except in the material from Wynaad (Mavinahalla, Ambalavayal) in which two cases with a doubtful quadrivalent were noted. The rest of the meiosis is normal (Figs. 7 and 8).

Garber² considers *S. nitidum* to be an allo-tetraploid species of the series Para-sorghum. Krishnaswamy and Raman¹ confirmed the number found by Garber. Based on the evidence obtained by the analysis of chromosome pairing in the interspecific hybrid *S. leiocladum* \times *S. nitidum*, Garber² derives the genomic constitution of nitidum as $L^b L^b L^c L^c$ the L^b genome being closely related to L^c of *S. leiocladum*. The karyotype of the 10-chromosomed *S. nitidum* is similar to that described by Garber for the 20-chromosomed plant. The nucleolar chromosomes, however, have remained only two in the 10-form. The question then arises how far the 10-chromosomed form is a diploid of the 20-form. If the latter were due to duplication, there should have been four nucleolar chromosomes but only two have been observed so far. Such a condition could have arisen by the loss of the nucleolus organising segment in one pair, but unless there has been complete change of homology, these two should have given occasional pairing with the nucleolar chromosomes and trivalents and quadrivalents could have been expected. The 20-chromosomed plant, however, exhibits only bivalents. The affinity between the diploid and tetraploid forms could only be determined by actual hybridisation. Garber³ has stated that only two diploid species are known in the para-sorghums. The present plant would form the third species.

Our thanks are due to Sri. D. Krishnaswami for help in taking the microphotographs and Sri. N. R. Ramamurthy in the collection of nitidum plants.

Cytogenetics Lab., N. KRISHNASWAMY.
Agric. Col. & Res. Inst., V. S. RAMAN.
Lawley Road, P.O., P. CHANDRASEKHARAN.
Coimbatore,
November 7, 1955.

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REVIEWS

Scattering and Diffraction of Radjo Waves.

By J. R. Mentzer. (Pergamon Press), 1955.
Pp. viii + 134. Price 30 sh.

This is a book in the series of monographs on *Electronics and Waves*, edited by Mr. D. W. Fry of Harwell.

The book deals with the mathematical methods of treating the problem of scattering of electromagnetic waves by bodies of different shapes with a view to their application to the calculation of echo cross-sections of radar targets. Rigorous calculations are possible only in a few simple cases such as a conducting or dielectric sphere, a long cylinder, an infinite conducting cone, a thin conducting plate, etc., the essential condition being that the wave equation can be "separated" in a co-ordinate system which is suited to the shape of the scattering object. In addition to the classical method, an alternative vector variational method due to Schwinger which can be used to obtain approximate solutions of practical diffraction problems is explained and applied to the important case of scattering by thin wires.

The last chapter deals with the techniques in use for the measurement of radar cross-sections of complicated scatterers like aircraft, using scale models on a convenient smaller scale and corresponding shorter wavelengths.

The book has many neat diagrams and is well printed. The exposition is clear and the book will prove very useful to advanced students and instructors in radio and radar physics. The price (30 sh.) is rather high for a book of 134 pages.

K. R. RAMANATHAN.

High Vacuum Technique. 3rd Edition. By J. Yarwood. (Chapman & Hall), 1955. Pp. viii + 208. Price 25 sh.

Modern high vacuum technique started with the pioneering work of Gaede in 1910 and since then, it has made several rapid strides, in answer to the need for very high order of vacuua to be maintained in large vacuum systems, both in the laboratory and industry. The appearance of a third edition of the book under review, within the last twelve years, indicates both the popularity of this book and the growing trends in the subject.

Compared to the previous editions, substantial additions have been made. Diffusion pump theory is analysed in greater detail and a number of recent innovations in vacuum gadgets like valves and other control devices are discussed. An important feature is the comparative data on the availability and performance of various types of rotary and diffusion pumps, oils and measuring devices of different manufactures. This information, together with the last chapter on the properties of some of the important materials used in vacuum technique, will be very useful for constructing a vacuum system.

The subject-matter is practically up to date except for some of the attempts, since 1953, at producing high vacua, without any working fluid like oil or mercury. But this is also indicated in principle, in the discussion of the pumping action of the ionisation gauge.

This, however, is a very minor criticism of an excellent book which will be instructing and informative for physicists and engineers.

K. S. CHANDRASEKARAN.

Antimetabolites and Cancer. Edited by C. P. Rhoads. (American Association for the Advancement of Science Publication), 1955. Pp. 312. Price \$5.75.

"Once cancer, always cancer" seemed to be the dictum, as voiced by C. P. Rhoads, of a school of cancerologists who believe in the somatic mutation as the origin of cancer. Since this hypothesis implies that mutations cannot be reversed or prevented by environmental or directive manner, this view-point is tinged with fatalistic implications. The field, however, is not so gloomy as it appears. For example, there is another school of workers who would like to consider cancer "as resulting from aberrations in morphogenesis" (Davis). "Since the morphogenetic changes do involve directive environmental influence, the morphogenetic aberration hypothesis has a much more cheerful implication, in that, if only we learn to modify the environment of a cell appropriately, we may be able to prevent or even reverse the neoplastic developments."

Whatever be the theories of the origin of cancer, the job of a person seeking to cure it becomes one of devising means for the selective restraint of growth or the destruction of

neoplastic cell, no matter where in the body it may be. Till recently, the only hope lay either in radical surgery or in radiation therapy, both of which have cured many early cancers. Recently a new and a promising tool, namely, antimetabolites, has been added in the armoury against cancer.

Interference with normal growth-pattern by inducing a chemical competition between a synthetic compound and an essential metabolite has been known for quite some time; but its potential implications were recognised only after its applications in bacteriostasis have been amply rewarded. The antimetabolite principle was first tried in chemotherapy of cancer as late as 1948. During the last six to seven years the field has grown so enormously that it is difficult to keep track of all the developments even for those who are actively on the lookout for information. The volume under review which records the proceedings of a symposium on Antimetabolites and Cancer, held under the auspices of the American Association for the Advancement of Science in 1953, is therefore a welcome one, even though its scope is limited to contributions from American workers only.

As the title of the book would suggest, the major portion deals with chemotherapy of cancer. There are, however, sections dealing with the applications of the antimetabolite principles in the studies of plant material, and of the protozoan tetrahymena as also in the normal mammalian fetal development.

Among the antimetabolites extensively investigated, aminopterin and A-methopterin feature prominently as the folic acid antagonists, and 2:6 diaminopurine, 6-mercaptopurine, 8-azaguanine and other analogues of purines and pyrimidines as the antinucleic acid metabolites. One of the necessary evils of antimetabolite therapy is the acquired drug resistance. This has partially been discussed although the reviewer would have liked to see this extensively discussed, since this forms the basis of the usefulness or otherwise of the antimetabolite principle. On the whole, the book is a very thought-provoking one and will be useful for all biological workers and particularly for those interested in the problem of cancer.

M. B. SAHASRABUDHE.

Rain-Making; Its Present Position and Future Possibilities. By A. K. Roy. (Published by CSIR, New Delhi), 1955. Pp. iii + 28.

Much has been written on this subject in the last few years in the scientific and the lay press, and the informative article by A. K.

Roy who is in charge of the Experimental Rain Cloud Physics Research Unit of the Council of Scientific and Industrial Research is very welcome. The article starts with the mode of rain formation in clouds, and discusses the possibilities of rain-making in supercooled and 'warm' clouds. This is followed by a critical assessment of the results of rain-making experiments conducted so far, and the article concludes by indicating the limitations of known techniques of rain-making. The monograph is well illustrated and includes a few photographs of successful rain-making, and contains also a select bibliography.

Methods in Enzymology, Vol. I. Edited by S. P. Colowick and N. O. Kaplan. (Academic Press), 1955. Pp. 835. Price \$18.00.

The present volume is the first of a series of four which the publishers propose to bring forth. The objective, as stated in the preface, is to present "for the first time in the English language, a comprehensive compilation of the methods used in the study of enzymes. In certain respects, this work should serve as a companion piece for Sumner and Myerback's "The Enzymes", in which methodology has been emphasised".

The book consists of four sections: general preparative procedures, enzymes of carbohydrate metabolism, enzymes of lipid metabolism and enzymes of citric acid cycle. As the name of the book indicates, much stress is laid on the methodology of enzymes, each enzyme being dealt with under the heads—assay methods, purification and properties. Section I is devoted to the general preparative procedures comprising tissue slice technique, tissue homogenates, fractionation of cellular components, methods of extraction and fractionation, and preparation of buffers. Section II deals with the enzymes of carbohydrate metabolism, preparation, purification, assay methods and properties of enzymes relating to the hydrolysis and synthesis of polysaccharides, metabolism of hexoses, pentoses, three-carbon compounds, two-carbon compounds and formate reactions. Section III relates to the enzymes of fatty acid oxidation and acyl transfer and activation; lipases and esterases and phospholipid and steroid enzymes. The enzymes of citric acid cycle have been dealt with in Section IV.

Leading scientists all over the world who are specialists in the particular field have contributed various articles in this book. Although it is not an exhaustive account of all aspects

of enzyme chemistry, it serves as a very useful guide and as laboratory manual not only for the enzymologist but also for those working in the fields of biological and medical sciences who have to evaluate the known enzymes in relation to other metabolic processes, in which enzymes play an important role in cellular function.

The book is pleasingly free from misprints. The format is good, and the Academic Press is to be congratulated upon its share in this fine work. The editing by S. P. Colowick and N. O. Kaplan also calls for praise.

K. V. GHIL

Origins of Resistance to Toxic Agents. Edited by M. G. Sevag, Roger D. Reid and O. E. Reynolds. (Academic Press), 1955. Pp. xv + 471. Price \$12.00.

The book under review records in its entirety the Symposium organised at Washington D.C. in March 1954 to discuss the "many facets" of the origins of drug resistance and related problems.

The editors took a broad view of the subject and posed basic questions (Appendix I) like the possibility of acquisition of drug resistance being associated with the emergence into prominence of pre-existing drug insensitive alternate metabolic pathways; acquisition of one or more detoxication mechanisms by the resistant cells; control and development of resistance; origin of drug resistant individuals, and many such others. The result has been to attract papers on such diverse topics as mechanisms of the origin of resistance to drugs in bacteria and protozoa, alcoholism and drug addiction, and mechanisms of carcinogenesis. Alterations and/or loss in enzyme proteins appear to be a feature common to all the phenomena discussed and hence the justification of bringing them all into a common focus. The inescapable conclusion that emerges from all these discussions, which incidentally are of a very fundamental and thought-provoking nature, is the meagreness of our knowledge concerning the potentialities of the living cell to devise means for counteracting the toxic action of a foreign body. The core of the problem has yet to be discovered.

Both the presentation of papers and discussions have been done in an admirable way. The genetotrophic approach to alcoholism by Roger Williams is especially commendable. He has based his approach on two facts: (i) proneness to alcoholism is a condition from which, in human experience, victims never recover,

and (ii) every individual person (alcoholic or not) is born with distinctive metabolic machinery that is genetically determined. Sevag's plea for assigning to proteins an equally important role in genetic variation as hitherto given to DNA and the lucid exposition of metabolic blocks by Mitchell, are some of the other important contributions. Enzymologists will find something of interest in every paper that has been presented in the Symposium.

It is satisfying to find that although workers in very diverse disciplines have contributed to a symposium, yet there is a common thread and unity of approach. Here is a model for symposia in our country.

D. L. SHRIVASTAVA.

Annual Review of Biochemistry, Vol. 24. (Published by Annual Reviews Inc., Stanford, California), 1955. Pp. xvi + 805. Price \$7.00.

This year's volume of the *Annual Review of Biochemistry* appears bulkier than some of the previous volumes in this series and has a pre-fatory article on Herman Augustus Spoehr (1885-1954) by Smith and French. This is followed by the usual review articles on biological oxidations by Green and Beinert, non-oxidative non-proteolytic enzymes by Axelrod, proteolytic enzymes by Schwert, chemistry of carbohydrates by Jones, chemistry of the phosphatides by Båer, metabolism of the complex lipides by Zilversmit, chemistry of proteins, peptides and amino acids by Ogston, carbohydrate metabolism by Horecker and Mehler, metabolism of amino acids and proteins by Ehrensverd, water-soluble vitamins (in three parts) by Briggs, Daft, Fried, Lardy and Johnson, fat-soluble vitamins by Boyer, lipide metabolism by Lynen and nutrition by Brock.

There are, besides, the following six special review articles on subjects of biochemical importance: (i) Nucleic acids by Brown and Todd, (ii) Carotenoids by Goodwin, (iii) Biochemistry of the steroid hormones by Roberts and Szego, (iv) Biochemistry of antibiotics, by Binkley, (v) Clinical applications of biochemistry by Bodansky, and (vi) Biochemistry of cancer, by Haddow. As may be seen from the names of the authors given above, these articles have been written by specialists who have worked extensively in their respective fields and who can therefore appreciate the merits and point out the defects among the very large number of research papers published during the year under review. Particular mention may, however, be made of the article on the

chemistry of the phosphatides, in which Dr. Baer has reviewed the more significant accomplishments such as "the isolation from baker's yeast of the first natural lecithin containing two unsaturated fatty acids and of thirteen individual lipopeptides from blood serum". Ogston in his review of the chemistry of proteins, peptides and amino acids has departed from the beaten track, by classifying the list of references under broad subject headings of his own, and by writing a short essay in which direct reference is made only to a small number of research papers. Brown and Todd have given an excellent account of nucleic acids as also Haddow on the biochemistry of cancer, the latter dealing extensively with the conception of carcinogenesis through loss of regulatory proteins, enzymes or antigens. Goodwin's article on carotenoids is very comprehensive and so are the two articles on the biochemistry of steroid hormones and of antibiotics. Oscar Bodansky has in his own inimitable fashion, dealt extensively on what he calls 'diagnostic biochemistry' and on the biochemical mechanisms in different diseases. The only article which appears to be slightly out of step is the one written by Dr. Brock on nutrition. For, apart from some vague generalities, he appears to have missed, in dealing with the 'Bifidus factor' of milk in p. 531, the latest developments so clearly mentioned in p. 453 under water-soluble vitamins. However, taking the volume as a whole, the editors have done remarkably well in covering a very wide field in the course of twenty articles.

The get-up of the volume is true to tradition, and considering the size, the volume is singularly free from serious errors or omissions. In the opinion of the reviewer, this annual number with such an excellent and varied fare, should prove as popular as ever among biochemists and others interested in the advancement of biochemical study and research.

P. S. SARMA.

Perspectives and Horizons in Microbiology.
Edited by Selman A. Waksman. (Rutgers University Press), 1955. Pp. x + 220. Price \$3.5.

The volume is a collection of papers presented at the symposium arranged in connection with the dedication of the Institute of Microbiology, Rutgers University, and very appropriately covers varied aspects of the science devoted to the study of the microscopic forms of life and their relation to mankind.

As the title rightly indicates, the authors of the different essays—all well known in their respective field of research—besides reviewing present knowledge, pose many unsolved problems, thus making the whole book very interesting and stimulating to read.

The essays are arranged under three main headings: The Microbe as a Living System; Metabolism of Micro-organism and Micro-organism and Higher Form of Life. Starting with C. B. Van Niels' essay on 'The Microbe as a Whole', where the author advocates studies directed towards understanding the fundamental aspects of life, the essays which follow have generally made the point that researches on varied aspects of microbiology have contributed a great deal to understanding the dynamic aspects of biochemistry and the general fields of ecology, taxonomy, evolution. Except for the essay on 'Metapoeitic Integration' by André Lwoff, which by the nature of the subject is highly specialized, the other essays are all lucidly written without too much of technical jargon and can be profitably read by non-specialist and specialist alike.

An appendix contains three addresses delivered at the dedication ceremony, and includes one by Waksman on the scientific method, the education of a scientist, and the function of the Institute, and an interesting historical survey 'From Dutch Settlements to the Rutgers University of Microbiology' by Prof. Kluyver. Organisation of such symposia at the opening of research institutions is a practice well worth emulating in this country.

V. S. GOVINDARAJAN.

Abstract Bibliography of Cotton Breeding and Genetics (1900-1950). By R. L. Knight. 1954. Pp. 256. Price 21 sh.

This book is published by the Commonwealth Bureau of Plant Breeding and Genetics, Cambridge, as Technical Communication No. 17. The author is well qualified to compile a work of this kind, as he has done much work on both cotton breeding and genetics in the Sudan. The book contains 1,191 citations to the literature, and there are three short Appendices. The first of these summarises the present state of our knowledge regarding the genomes of the genus *Gossypium*; the second contains a complete list of all the genes so far identified in the genus; the third summarises what is known of linkage relationships in both Old and New World cottons.

All important work is adequately, sometimes lengthily, summarised and there are few

omissions. The list of genes in *Appendix II* omits the three genes discovered in *G. armourianum* by the reviewer. A lumping together of all the genes known in the genus is a disputable procedure. There is a good index. As a work of reference, the present volume is indispensable to all cotton workers. Those working on other crops will find stimulation and valuable information in its pages. S. C. HARLAND.

Introduction to Theoretical Organic Chemistry.

By P. H. Hermans. Edited and Revised by R. E. Reeves. (Elseviers), 1954. Pp. xii + 507. Price 38 sh. 6 d.

The expressed purpose of this book is to present an elementary and general picture of the advances in theoretical organic chemistry that have been made in the last twenty-five years. The author has not attempted to give a detailed treatment of the subject but rather to give a broad survey of the entire field of physical organic chemistry. The topics discussed are various and include quantum mechanics, structure theory, stereochemistry, spectroscopy, equilibria and reaction kinetics and mechanism of ionic and free radical reactions. The inclusion of such a large number of subjects for discussion in a book of this size has resulted in a somewhat superficial coverage of some sections.

The author is at his best in his discussions of the physical aspects of organic chemistry. The chapters on stereochemistry, resonance, refraction, polarisation and magnetic properties of molecules are written particularly well. The later chapters dealing with mechanisms of organic reactions are written in a conventional but uncritical manner. Well-established and classic studies are often placed alongside with casual suggestions of some authors, and the reader has no way of distinguishing between them. Furthermore, some errors of fact have crept in which will no doubt be corrected in future editions. In the section on applications of resonance concept, tautomeric forms of pyrazole are wrongly described as resonance structures. Again on p. 327, lithium hydride (instead of lithium aluminium hydride) is referred to as a reducing agent for ketones. The role of steric factors in organic reactions has not received the attention it deserves.

Despite these shortcomings, the book will be found useful by students wishing to keep abreast of recent developments in the field of theoretical organic chemistry, particularly if supplemented by a course of lectures.

S. SWAMINATHAN.

Books Received

Numerical Analysis. By Zdenek Kopal. (Chapman & Hall), 1955. Pp. xiv + 556. Price 63 sh.

Law and the Engineer. By Christopher F. Mayson. (Chapman & Hall), 1955. Pp. xx + 470. Price 63 sh.

Ostodes of Whales and Dolphins from the Discovery Collections—Discovery Reports. By S. Markowski. (Cambridge University Press), 1955. Pp. 377-95. Price 12 sh. 6 d.

Vacuum Valves in Pulse Technique. By P. A. Neeteson. (Philips Technical Library), 1955. Pp. viii + 170. Price Rs. 12-8-0.

Experimental Design and Its Statistical Basis. By D. J. Finney. (Cambridge University Press), 1955. Pp. xi + 168. Price 30 sh.

Flood Estimation and Control. Third Edition. Revised. By B. D. Richards. (Chapman & Hall), 1955. Pp. xiii + 187. Price 35 sh.

Principles and Problems in Energetics. By J. N. Bronsted. (Translated from Danish by R. P. Bell.) (Interscience Publishers, Inc., New York), 1955. Pp. vii + 119. Price \$ 3.50.

Mysidacea—Discovery Reports, Vol. XXVIII. By E. Tattersall. (Cambridge University Press), 1955. Pp. 1-190. Price 65 sh.

Biology of Poliomyelitis—Annals of the New York Academy of Sciences, Vol. 61, Art. 4. Pp. 737-1064. Price \$ 5.00.

Psychotherapy and Counselling—Annals of the New York Academy of Sciences, Vol. 63, Art. 3. 1955. Pp. 319-432. Price \$ 3.50.

The Geometry of Geodesics—Mathematics Monograph, Vol. VI. By Herbert Brusemann. (Academic Press), 1955. Pp. vii + 422. Price \$ 9.00.

Ancient India—Special Jubilee Number of Archaeological Survey of India, 1902-52, No. 9. (The Director-General of Archaeology of India, New Delhi), 1953. Pp. 1-233. Price Rs. 17.

Advances in Virus Research, Vol. III. By Kenneth M. Smith and Max A. Lauffer. (Academic Press), 1955. Pp. ix + 338. Price \$ 18.00.

Synthetic Ion-Exchangers—Recent Developments in Theory and Application. By G. H. Osborn. (Chapman & Hall), 1955. Pp. ix + 419. Price 30 sh.

Steels for the User. Third Edition. By R. T. Rolfe. (Chapman & Hall), 1955. Pp. xvi + 399. Price 45 sh.

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SCIENCE NOTES AND NEWS

Southern Languages Book Trust

The Southern Languages Book Trust is planning to compile a list of all publishers, book-sellers, printers, authors, artists and translators in South India and also compile a list of all organisations interested in these fields. The Book Trust, therefore, invites all those concerned to write to the General Manager, Southern Languages Book Trust, 3, Wheat Croft Road, Nungambakkam, Madras-31, for further particulars.

Scintillation Counter for Human Subjects

The Los Alamos Scientific Laboratory has built a scintillation detector large enough to accommodate a human body and to measure its accumulated amount of radioactivity. The scintillation detector is a large cylindrical tank, 6 feet long and 28 inches in diameter. Through it runs a cavity large enough to contain the human subject to be measured. The walls of the tank contain a liquid which gives off minute flashes of light when gamma rays from the person pass through it. This light is detected and amplified by 108 photomultiplier tubes installed in the outer wall of the tank. Electronic instruments record the number of gamma rays registered. The entire tank is surrounded by a ten-ton lead shield to reduce interference by external radioactivities.

Peaceful Uses of Atomic Energy: India and the United Kingdom

Discussions between the United Kingdom Atomic Energy Authority and the Indian Department of Atomic Energy have led to the conclusion of an agreement which ensures that there shall be close co-operation and mutual assistance between the Authority and the Department in the promotion and development of the peaceful uses of atomic energy. The agreement provides for the Authority and the Department to arrange for members of their staffs to consult and work together on mutually agreed topics. In furtherance of this agreement, the United Kingdom Atomic Energy Authority will provide the Indian Department of Atomic Energy with enriched uranium fuel elements for a 'swimming pool' reactor now under construction at Bombay. The agreement also includes arrangements for the Authority to assist in the design and construction of a high-flux research reactor which may be built at a later date.

Study of Tropical Vegetation

The UNESCO South Asia Science Co-operation Office in New Delhi is organizing a symposium on the 'Study of Tropical Vegetation' in Kandy (Ceylon) from 19-21 March 1956. The twenty participants have been invited from Europe, U.S.A., Australia and six countries from South and South-East Asia.

The principal object of the symposium is to attempt to reach international accord on the question of nomenclature and classification of types of tropical vegetation. It is planned to collate information on what has been done on mapping of forests, grasslands and other types of tropical vegetation and to discuss techniques which are being used and which are recommended to be used for the study of these types of vegetation. Since taxonomic work is an essential prerequisite for detailed studies of plant communities, a discussion on this topic for various territories will be held.

Immediately following this programme, the preparatory meeting of specialists in Humid Tropics Research will also be held in Kandy.

Geological, Mining and Metallurgical Society of India

At the Thirty-First Annual General Meeting of the Society held recently, the following office-bearers for 1955-56 were elected:

President: Dr. C. S. Pichamuthu, Bangalore;
Vice-Presidents: Mr. Jayantilal Ojha, Calcutta, and Mr. W. B. Metre, Digboi; **Joint-Secretaries:** Prof. N. N. Chatterjee, Calcutta, and Prof. N. L. Sharma, Dhanbad.

Tata Medal Award For Zoology

The Zoological Society of India has awarded the Sir Dorab Tata Gold Medal to Dr. M. L. Roonwal, Forest Entomologist, at the Forest Research Institute, Dehra Dun, for his significant contributions to Zoology during 1952-54.

Dr. M. L. Roonwal has published a good many papers dealing with locust and other acrididae, forest entomology in general, termites, and teredinid boring bivalves in relation to forestry. His contributions on the desert locust are valuable both from the scientific and economic aspects, and lead to a better understanding of phase-transformation and population dynamics of the desert locust. He has also materially contributed towards the understanding of the problem of intraspecific variability.

Indian Society for the History of Science

The formation of an Indian Society for the History of Science is being sponsored by a number of prominent scientists and historians in the country. The objects of the Society will be to promote the study of the history of science in India by arranging lectures, discussions and symposia on different aspects of history of science; eliciting support of various national institutions and universities to sponsor research on different aspects of the history of science and technology in India; disseminating the results of research through meetings and discussions, and publication of relevant material in suitable journals; and drawing the attention of the universities to the importance of teaching the history of science.

Scientists and historians in India are requested to become members of this Society and lend their active support to it. Further information can be had from Dr. A. Rahman, Central Laboratories, Hyderabad (Dn.).

Chrome Tanning Industry and Tanning Processes

A symposium on chrome tanning industry and tanning processes will be held during the 3rd week of March 1956, in Calcutta, under the auspices of the Leather Technologists' Association (India). The object of the symposium is to foster exchange of ideas and thoughts between the leather technologists, tanners, research workers and people of the leather trade from all over India. The exact date and programme will be notified later. Further details can be had from: The Editor, *Journal of the Leather Technologists' Association (India)*, Bengal Tanning Institute, Canal South Road, Calcutta-15.

Nuclear Science and Engineering

The American Nuclear Society is sponsoring the publication of a Journal with the above title, devoted to the presentation of theoretical and experimental papers relating to such subjects as nuclear reactor design, construction, operation; interaction of nuclear radiations and matter, basic phenomena in performance of nuclear fuels; production, uses and disposal of radioactive materials; chemical processing of nuclear fuels; basic and applied neutron physics;

heat transfer problems peculiar to nuclear reactors; technology of reactor materials; radiological safety, health physics, nuclear radiation shielding; nuclear instruments research and development; reactor and fission physics; systems for remote handling of radioactive materials; nuclear reactor stability and control; controlled release energy from nuclear fusion.

It is planned to publish one volume per year. Volume 1, Number 1, is scheduled for release in February 1956. Subscriptions for Volume 1, priced at \$10.00, should be sent to the publishers, Academic Press Inc., 125 East, 23rd Street, New York 10, New York.

Strengthening Thorium

H. R. Ogden, R. M. Goldhoff, and R. J. Jaffee of the Battelle Institute, Columbus, Ohio, report that thorium can be significantly strengthened for use in nuclear reactors by alloying with carbon. Forty-eight elements were tried as additions to thorium, but most of them did not appreciably affect the strength when added in dilute quantities. Alloying with 0.25 weight per cent. of carbon, however, could double the tensile strength. In addition, precipitation hardening and cold working further enhanced the strength of the thorium-carbon alloys.

The Institution of Telecommunication Engineers

The last date for receipt of applications for the first series of Graduateship and Studentship Examinations has been extended to March 15, instead of January 31, as announced earlier in this *Journal* (1955, 24, p. 434).

Award of Research Degree

The Aligarh University has awarded the Ph.D. Degree in Geology to Shri H. Pareek for his thesis entitled, "The Petrological Study of Talcher Coals".

The University of Bombay has awarded the Ph.D. Degree in Physics to Sri. R. D. Joshi for his thesis entitled, "Some Spectral Problems connected with N₂ Band System".

The University of Poona has awarded the Ph.D. Degree in Engineering to Shri K. R. Phadke for his thesis entitled, "Measurement of Atmospheric Noise Interference to Broadcasting in 3 and 5 Mc/s. bands at Poona".

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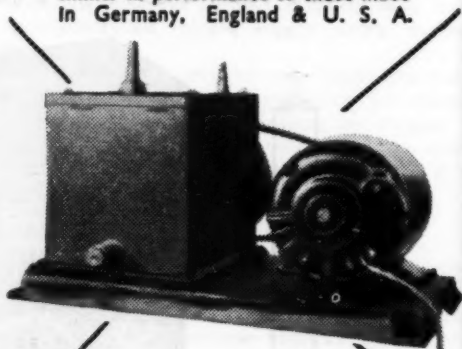
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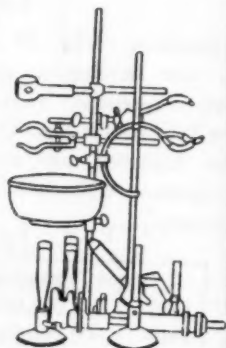
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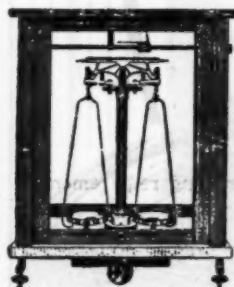
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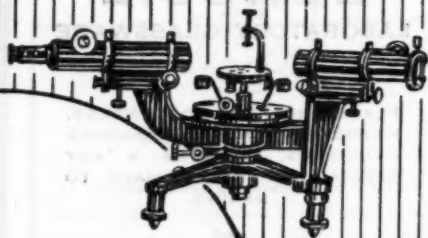
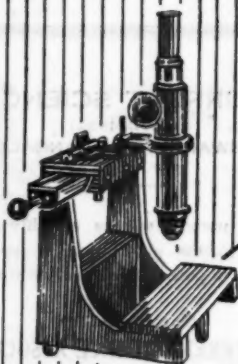
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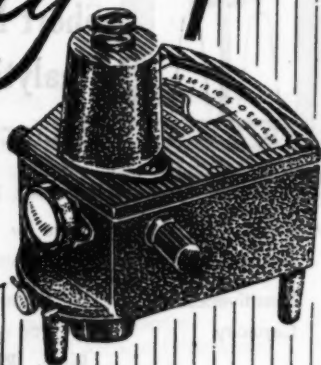
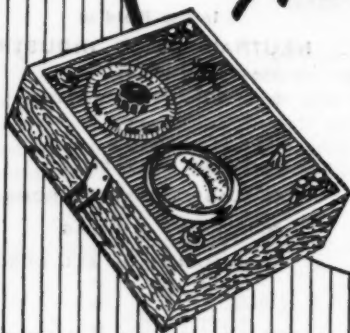
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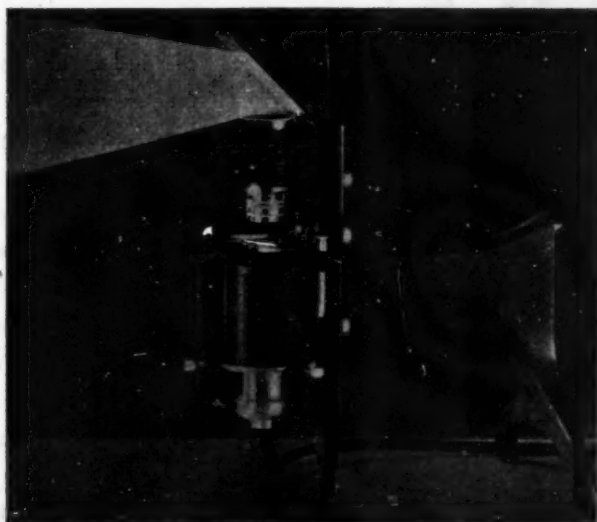
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